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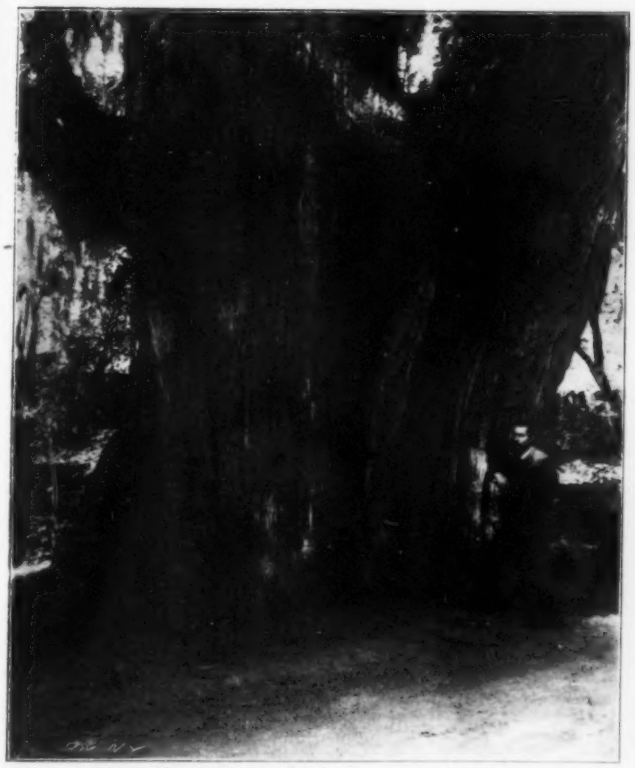
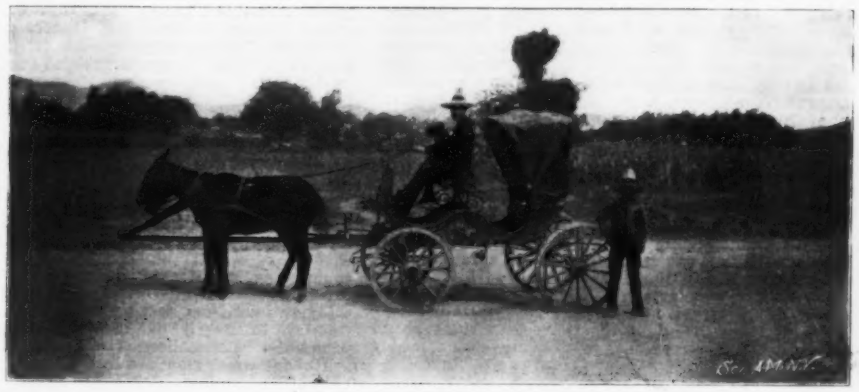
CITY OF MEXICO—CANAL DUG BY CORTEZ TO DRAIN THE VALLEY OF MEXICO.

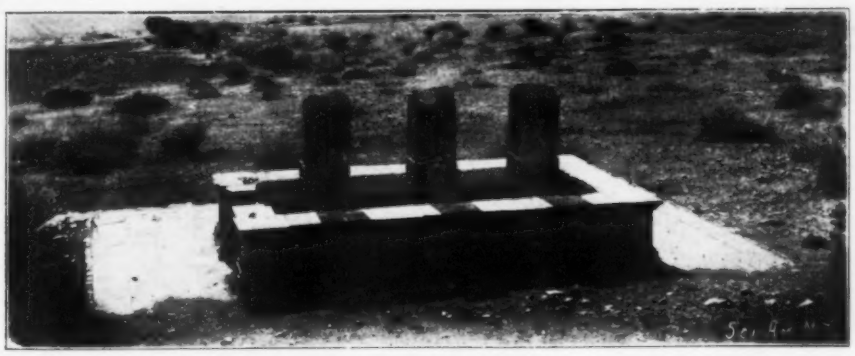
AVENUE OF MAGUEY PLANTS.



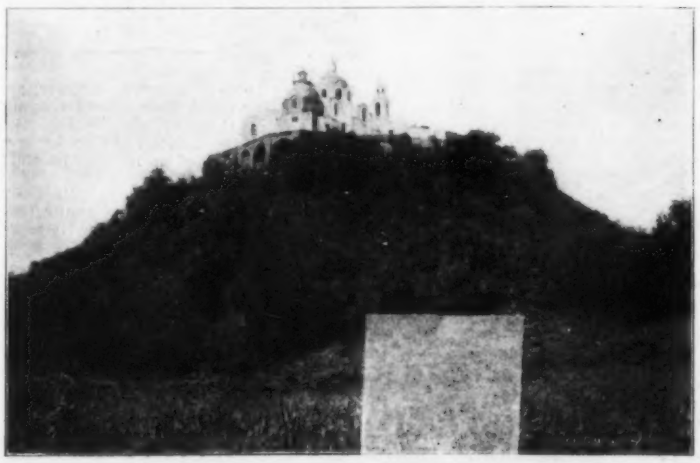
GREAT CYPRESS TREE, DIAMETER 19½ FEET.



SPANISH COUNTRY CARRIAGE.



QUERETARO—PLACE OF MAXIMILIAN'S EXECUTION.



AZTEC PYRAMID—CHAHULA. EASTERN VIEW.

VALLEY OF PUEBLO FROM TOP OF AZTEC PYRAMID.

MEETING OF THE PAN-AMERICAN CONGRESS IN THE CITY OF MEXICO.

[Continued from SUPPLEMENT No. 1361, page 21806.]

MEXICO—II.

SUGAR.

ONE of the largest industries of Mexico is that of sugar production from the cane. There are various phases of activity on a cane plantation—the cutting, stripping, and hauling of the cane to the sugar mills, which, in some cases, are mills up to date in their appointments; while in other places are what may be called ordinary sorghum mills, crushing the cane and boiling it by hand.

It happens to be the business of the Philadelphia Commercial Museums to find out the location of all the mines, sugar and other mills that use machinery, belting, pulleys, etc.; we have learned the names of all, and their location in Mexico and other Latin-American countries for the benefit of our manufacturers here; and that information we give out, showing them what the sugar industry is in Brazil and Mexico and when they will need new boilers and machines.

FIBER INDUSTRY.

The fiber industry is one of the largest in Mexico. Leading all is a fiber coming from a plant allied to the Century plant, called the Henequen plant. It contains an enormous percentage of water—a leaf weighing 25 to 35 pounds producing probably about a pound of dry fiber. These immense plants are cultivated in Yucatan in great plantations, in rows about seven feet apart; and when the plant comes to maturity, in six or seven years, they begin to cut the leaves, wherever they are large enough, and cart them to a machine which runs the leaves through rollers, crushing them—there being a stream of water played upon it, washing out the pulp; and in that way one machine will run out a great many pounds of fiber and it will dry out before night.

These various fibers go into the market under the names, respectively, of henequen, maguey and ixtle—the ixtle being a very short fiber, while the henequen and maguey are very long and woody. We import, annually, from Mexico alone about $5,000,000 worth of that fiber for rope and hammock making and a variety of other purposes.

In the century plant and all of these plants there is a little spine on the tip of the leaf, and the native Indians make a very important use thereof. They take the leaf with the spine on the end of it and split it right down on either side, macerating the spine so that there is a thin line all the way down the leaf. They then wash out the pulp and here is a natural needle—that spine on the end of it and the fiber all the way down naturally attached to it. They don't have to thread the needle at all. The fiber naturally grew right on the end of the needle and makes a perfect instrument for sewing bags, coffee sacks and all that sort of thing without the use of any artificial device.

There are numbers of other fiber plants which belong with the maguey, henequen, and ixtle; one of them is ramie—one of the coming fibers. We have not yet accomplished the perfect spinning of it; but it looks like silk when it is nicely peeled and is already used to a certain extent to adulterate it; and these little japanette handkerchiefs sold in the market for ten to fifteen cents apiece are made of ramie. There are only one or two mills in the world that have learned to turn out a fine product.

Cotton is an extensive product of Mexico. They raise what cotton they want for themselves, and they have been introducing recently a great many cotton mills which yield a large return upon the capital invested. Labor is cheap and they are making all their coarse cottons, white cottons and calicoes; and these goods are all on exhibit at the Philadelphia Commercial Museums. The calico patterns evince no taste whatever; you would know that they were made by a rude people. They have not developed them as we have, artistically.

Rubber is another important industry of Mexico in certain parts. The exportations are steadily growing.

GUM CHICLE.

Another important product is that of chicle, which is gum from a small tree, 25 to 30 feet high, and which comes to this country to the extent of nearly a million dollars a year, being the basis of all the chewing gum that we use. The tree is tapped and produces a white fluid; that fluid is evaporated by the natives, sometimes in the sun, and sometimes in their crude earthen crocks, over a little fire, becoming a black or dark brown. It is dried out thoroughly and boiled in that way, bringing in the market 27, 35 to 37 cents a pound in this crude state before it is refined.

MISCELLANEOUS PRODUCTS.

There are a good many kinds of vegetable waxes, and one is of extreme importance, coming from the *Myrita cerifera*, which occurs from New England all the way down through the United States to Florida and all the way through New Mexico. Our New England forefathers, when first they came to our shores, picked off the bunches of fruit and threw them into vessels of hot water; the wax flowed out on the top of the water and they gathered it by the pound and made wax candles, and it was used a great deal. The Mexicans are doing that constantly now; they use thousands of pounds of the wax produced from this bush. The Central Americans are doing it the same way as we did by taking a wick and dipping the wick in; and it produces exactly the same shaped candle that we used to produce, as I remember, by dipping a wick into a kettle of tallow. In the northern part of Central America they have gotten a little more civilized and have imported our old-fashioned tin molds.

One of the extensive products in Mexico is its cacao or cocoa. The fruits are over eight or ten inches long; and on cutting them open one finds inside the seeds, which, when crushed, furnish the crude cocoas, and when crushed up with moisture, furnish the chocolate. It is from these that all the preparations of chocolate are made.

Another line of products is the cocoanut; and that grows all around the coast, everywhere, in Mexico.

The banana is being cultivated all over Mexico, especially the southern part, where it is made a very profitable crop and grown by the natives everywhere for their food. They are shipped very extensively from Yucatan, and certain ports of lower Mexico, to the United States.

Oranges are also one of the most prominent fruits of Mexico. A hard freeze in Florida a few years ago killed almost all the oranges (Florida was then shipping over $4,000,000 worth a year) and stimulated the Mexican trade (where orange trees were scattered all over the country), and they began to cultivate groves. At that time we had no duty; and the Texans reaped the benefit of oranges brought into Texas at about 15 cents a dozen—a very delicious sort, too. A tariff was put on which cut off the shipment into Texas, into St. Louis and the ports that were reached by the Mexican shipper, and practically destroyed the trade.

Just a word or two with reference to the products I have with me on the platform, and which you can examine at your leisure. Here are the ordinary wares produced in Mexico, of patterns comparatively crude. Here is one of the Mexican-made hammocks; and some of the prominent Mexican woods, including cedar and other woods imported into this country. Here is a ball of ramie, just as it is now made by the best factory in England, where there are two factories making it in excellent shape. The ramie is an overgrown nettle (but the same family as our ordinary nettle), and the fibers come from the outside. Here is a handsome specimen of the rubber coming from the rubber tree in Mexico. This rubber is the sap—a ropy milk—just as it comes from the tree. The Indians take this milk in a large earthen jar, or sometimes in an opening scooped out in the ground. Having collected it from the tree and gathered it in this place they take a wide paddle (having built a little fire just by), and dipping the paddle into the white fluid, with a skillful waving of it over the smoking fire the water is evaporated out of the juice until it is dried down sufficiently and becomes black so that it is in a gummy condition; then it is wiped off the paddle into the mass, and the paddle is dipped in again and carefully and skillfully moved over the fire until it is evaporated again; and in that way this white fluid, dried down, becomes this mass of darkened rubber.

RUBBER.

A very curious way the natives of Africa have of gathering the rubber (there mainly derived from vines) is, while in almost naked condition themselves, as is their wont, to cut slits down the vine; and as the juice oozes out, perfectly white as you see it from milkweed, to wipe off the milk onto the arms and chest. In a half minute the moisture is evaporated out of it and a little thin film of gum is formed. The gum that comes from certain parts of that country is peelings composed of forty, fifty, or a hundred layers; and all the rubber thence exported is dried on the human skin in films, as described, and, after sufficient accumulation, peeled off and rolled into balls.

COMMERCE.

Mexico is the only Latin-American country which gives its preponderance of trade to the United States. There are about $20,000,000 exported of American manufactured goods and wares into Mexico and about $20,000,000 returned to this country. The trade is on an even balance; and it is the only Latin-American country of which this can be said. Taking such a country as Brazil: we buy between $60,000,000 and $70,000,000 worth of coffee alone, besides all the other things we get from her; yet the total exports from this country to Brazil are about $17,000,000—showing where the balance lies. The reason that we buy and sell about equal amounts to Mexico is, first of all, the enlightened policy of its President, who is taking every pains to educate his people for commerce with the United States and with English-speaking people; and next the proximity, and the ease of communication by railroad and steamers; as we have lines running direct from New York to Tampico and Vera Cruz; and railroads, too, connecting through the whole length of Mexico. In Brazil, the capital which has provided the main means for the cultivation of coffee and for the improvements—railroads and the general enlightenment of the people—has come from England, and England holds the balance of power in her trade, which it is very natural she should. In Mexico we are entering and investing our capital, and it is natural that we should hold the balance of trade outside of her other trade connections.

The products sent here by the Mexican government fill six rooms at the Philadelphia Commercial Museums; and the public is always welcome to enter and examine. That institution also numbers among its features a library affording more information on the statistics of different countries than elsewhere to be found in the United States—Washington, even, not excepted. For some years past we have been inviting every government on the face of the globe to send us their statistics and publications and all the material which would enlighten us and enable us in an intelligent way to know about the facilities of the different countries; we have there the official journals and publications from over thirty different governments coming to us regularly; our reading rooms and library (open to the public) contain 1,150 current journals, trade journals and technical journals from every quarter of the globe. The exhibits include all descriptions of raw products from all parts of the earth.—Abstract of a lecture delivered at the Temple College, Philadelphia, by Dr. W. P. Wilson, Director of the Philadelphia Commercial Museums.

FERTILIZING VALUE OF OIL CAKE.*

THROUGHOUT the north of France oleaginous seed cakes are employed as a fertilizer. Still, there is a difference as to the preference to be given. It depends oftenest on the original cost and the richness in nitrogen.

Wishing to decide the question, we undertook at the Berthonval Agricultural School two years ago an investigation of some of the most commonly used oil cakes. The result was that we were able to classify the cakes in the following order: sesame, camline, colza, rape, arachis, castor bean and cotton seed. But this scale of efficacy is only comparative. A single year is not sufficient for perfectly reliable agricultural experiments. The meteorological conditions, as M. Dehérain says, have such an influence on the results that fear may be entertained that they may not be found constant. We have therefore continued our researches, modifying the program slightly. In the new experiments we proposed:

1. To determine the influence of the residues not exhausted on ulterior cultivation.

2. To verify the conclusions drawn from the first series of experiments, on the efficacy of oil cake from different sources.

3. To ascertain the influence of the time of application on the decomposition of oil cake and its assimilation by plants.

Throughout the north these fertilizers are generally divided into "warm" and "cold" oil cakes, according to the rapidity of the effect. Thus, sesame, poppy, castor, camline, are designated warm, while arachis, colza, linseed, rape, pass for cold, because their energy is less and their operation slower.

To verify this hypothesis we planted again the spaces occupied in our first experiments with oats and sugar beets, without any application of fertilizer for the new cultivation. The wheat that succeeded the beets was finely developed, and we were able to notice at threshing that the continued influence of the fertilizer was quite marked, but varied with different seed cakes. Colza, arachis, rape, caused a greater production than sesame, camline and castor oil. The former exhibited the least energy in the first year, but all of them were found valuable. The increased value of the second product amounted per hectare to 85.80 francs for the arachis, 87.40 francs for the colza, 77.40 francs for the rape, 63.10 for the sesame, 43.60 for the camline, 24.60 for the castor, and 29.60 francs for the cottonseed oil.

It would be wrong, therefore, not to take account of the residuary strength of the fertilizer. Still, it may be remarked that these results were due to the slow incorporation of the oil cake and the persistent dryness of the season, which prevented the nitrogen from being so transformed in the soil as to conduce to the greatest advantage. The results are different when the nitrification is not impeded, the decomposition of the oil cake being subordinated to the presence of suitable moisture in the soil. Thus, for the forage beets which succeeded the oats, on which the action of the oil cake had been more decided, the subsequent influence was only moderately apparent. The surplus of the harvest rose to 3,100 kilos for the arachis oil against 1,200 kilos for the castor oil cake.

The efficacy of the oil cake depends, therefore, upon the time of application. If incorporated for a long time before sowing these fertilizers act almost entirely on the first crop, but if they are spread later the action is less apparent at first, especially in dry years, but continues on the subsequent crops, though the loss of nitrogen by drainage water is to be feared.

To make a judicious employment of oil cake it is necessary to have regard, not only for the meteorological nature of the soil, but also for the nature of the plant cultivated. Our experiments on the sugar beet furnished a striking example. These were conducted in the following manner: Ten parcels of one "are" each were divided into halves. On the first part the oil cake was incorporated during the winter; on the second the application was made under the same conditions, but at a date very near the sowing; that is, almost the end of April.

The oil cake was employed in the proportion of 1,000 kilos per hectare. The sowing took place on the 4th of May in rows separated by 40 centimeters, and the first appearance was very good. In June a slight difference was noted in favor of the parcels enriched during the winter. All the seed cakes, as we were enabled to verify at the harvest, produced an excess of yield as compared with the parcel not enriched. The sesame, which stood in the first rank previously, still showed itself superior to the arachis, the colza, the rape and the poppy, which we experimented on for the first time. The differences rose to 8,700 for the sesame, 8,000 for the poppy, 6,900 for the camline, 6,800 for the arachis, 6,200 for the colza, and 4,400 for the cottonseed cake. The application of the fertilizers during the winter was very advantageous, and when we compare the excess obtained by the same oil cakes employed at different periods we find the difference quite noticeable. Thus the sesame yielded only a surplus of 6,500 kilos of roots, the poppy 6,600, the arachis 4,900 and the cotton oil cake 2,700.

It appears preferable, according to these experiments to incorporate the oil cake as soon as possible toward the end of winter or early in the spring so that it may have the requisite time to decompose and serve for the vegetation. The application of oil cake at the moment of planting is of little advantage, especially for the kinds regarded as cold, like the colza, rape and arachis, and less favorable if the summer is dry.

Conclusions.—Several important conclusions result from our observation during two consecutive years while employing oil cake on different crops:

1. The seed cakes act in very different manner, according to their nature and the time of their application. For spring sowing those of rapid action, like the poppy, the castor and the sesame, are to be preferred, and they should be applied as long as possible before the sowing.

2. The influence of the residuary strength is quite noticeable when the season is dry and the application late. It is less when the action the first year is more apparent.

3. Employed under identical conditions they are far from having the same limit of action. Sesame, poppy, castor, camline act more rapidly than colza, rape, arachis and cottonseed. The latter might well be reserved for autumn cultivation.

4. According to benefit resulting from the application of different oil cakes, and taking the average obtained on different crops we think we are able to rely on the following order as to their value; Sesame, poppy, castor, camline, colza, rape, cotton, arachis, palm kernel oil cake. The scale is not absolute, but it presents at least to cultivators the general idea of the effects to be expected from the products offered in the trade, of which the price is too often not in accord with their fertilizing value.

* From the French of Prof. Maipaux, of the Berthonval Agricultural School, in the Annales Agronomiques.

RELATIONS BETWEEN GEOLOGY OF PETROLEUM AND ITS ORIGIN.*

IN geology every proposition not supported by experience may be considered as Utopian. For this reason, without speaking disrespectfully of the theories that have been announced as to the presence of petroleum in the older geological formations, I cannot leave the domain of facts and the deductions from them, based on the discovery of deposits in countries where the oozing of petroleum has been noticed on the surface.

In Algeria all the facts that we have been able to observe have only confirmed our theory. It is in tertiary formations exclusively that the presence of petroleum has been ascertained. This is true in Galicia, Roumania, the Caucasus, the Transcaspian, Turkestan, Persia, Assam, Burma, China and Japan.

We have now Algeria to add to the proof of the organic origin of petroleum in sedimentary lands. This invalidates the bold and seductive theories that have issued from other laboratories than the great laboratory of nature. Although the arguments are numerous, there are but two hypotheses with regard to the origin of petroleum—that of the chemists, who believe in an instantaneous reaction, a direct combination of hydrogen and carbon; and that of the geologists, who see in petroleum the product of a slow decomposition of organic matter.

The chemists, in the interesting experiments of the laboratory, are able to compose artificial petroleum, as they are able to compose many other substances by the combination of their elements.

The opinion of the geologists is founded on the observation and comparison of different petroleum-bearing formations which they have been able to study. They have not thought of ascribing to the liquid combustible, petroleum, a quite different origin from that of the other mineral combustibles, to which it offers more than one point of resemblance, especially to the liquid hydrocarbons that can be extracted from them. They have believed that the origin of a combination of hydrogen and carbon may consistently with the principles of chemistry be referred to a marine organic decomposition, producing the natural formation of hydrogen carbides.

Engler has demonstrated conclusively that this supposition can be supported by experiment. In 1888, he commenced his researches on the origin of petroleum, which he attributed to the combined action of heat and pressure on the soft parts of the organisms peopling the paleozoic seas.

To support his opinion, he tried the following experiment: In an autoclave connected with a condenser, he submitted to distillation 472 kilogrammes of clear, brown cod liver oil of the density of 0.930. At the commencement of the experiment, the pressure was 10 atmospheres, but in the course of distillation it sank to 4 atmospheres. The initial temperature of 320 deg. was carried to 400 deg. Soon combustible gases were disengaged from the condenser; then an oil. The latter, containing acids or fatty bodies, was in part saponifiable. The matter obtained was submitted to a second distillation under pressure and in the same conditions as the first, and 299 kilogrammes of oil of a density of 0.810 were collected, emitting vapor at 44 deg. C.: its odor was not disagreeable; no trace of acrolein was found in it; its color was brownish, with pronounced green fluorescence. Of 100 cubic centimeters of oil, 0.4 was soluble in water; 4.8 in potash solution; 20.8 in sulphuric acid of 66.9 deg.; 6 in a mixture of fuming acid of 66 deg.

The remainder was fractionally distilled under the same conditions. These were the results: below 150 deg., 29.5 per cent (in vol.) of density of 0.712; from 150 deg. to 300 deg., 57.5 per cent of density, 0.817; above 300 deg., 13 per cent. From the fatty acids of the liquids obtained non-saturated carbides were found, and especially saturated carbides. These were separated and studied with chemical treatment and close rectifications, notably the normal pentanes, hexanes and octanes, boiling respectively at about 37.68 and 98 deg., and having for density 0.622, 0.664 and 0.688.

On renewing his experiments Engler operated on 492 kilogrammes of fish and obtained a result almost identical.

It follows from these experiments that petroleum is a result of distillation of organic animal matter under pressure in the great laboratory of nature.† Besides, it would be very difficult to come to any other conclusion except a purely organic origin, when we consider the coral deposits of the Red Sea, in which petroleum has been discovered. In this formation mineral oil has been found, disseminated in small drops in cells completely closed, formed by the animalcules which produced the deposit. Here there is no trace of geologic upheaval, and such would be quite improbable in a formation comparatively recent. There is no room for an hypothesis other than that of an origin dependent on a decomposition which has taken place in the formation itself, where the petroleum is indigenous.

Geological facts quite similar have been observed in Canada in deposits of fossilized oysters (Ostrea multicustata, common in Algeria) which have preserved the form of the bank. There no break, no fissure, allows the supposition of any geologic upheaval. The underlying calcareous deposit (Trenton formation) is entirely free from all bituminous or petroliferous infiltration. The shells of the bank alone are almost without exception filled with petroleum proceeding without doubt from the decomposition of their soft substances.

One of the arguments which has been opposed to the theory of the organic animal origin of mineral oils is the claimed absence of nitrogen and its conbinations in petroleum. This indicates strange ignorance of the subject on the part of the chemists who have made this assertion.

Ste. Claire Deville found in a sample of mineral oil proceeding from Pechelbronn 0.25 per cent of nitrogen. In petroleum from the same source Engler discovered proportions varying between 0.89 and 1.70 per cent. This fact might have been considered as exceptional and a peculiarity of the Pechelbronn petroleum if Boussingault had not isolated nitrogen from the petroleums of China and Egypt and the asphalt of India, Auvergne and the province of Antioch.

Afterward, Feodorowicz discovered ammonia in the petroleum of Siary (Galicia). Delesse in his work on Nitrogen in the Terrestrial Shell mentions the presence of this metalloid in Trinity pitch, and Stromeyer notices it in the asphalt of Bienheim. For a long time it was thought that American petroleums were devoid of nitrogen, but Carnegie noticed near Pittsburg, Pa., the existence of crystals of ammonium carbonate on the borders of the gas springs frequent in the neighborhood. Peckham, also, discovered it in the mineral oils of Ohio and California. Beilby speaks of 0.05 per cent of nitrogen in the crude oil proceeding from Bakoo.

It may therefore be taken for granted that by natural distillation within the earth, products poor in nitrogen have been formed to the advantage of other residuary elements which they have enriched.

Höfer gives another reason for the low percentage of nitrogen in petroleums. According to him, it is in the gases emitted at the time of the decomposition of animal matter from which mineral oils have been formed, that nitrogen would be wholly or partially dissipated. The apodicere, or wax of dead bodies, which is often found in graves, is almost always destitute of nitrogen.

These facts are not opposed to chemistry, and on the other hand the theory of chemists seems but little in accord with the geologic conditions which have prevailed in nearly all the petroliferous formations of the world.

Petroleum, indeed, does not appear to have any affinity with plutonic formations. In these, important petroliferous bearings have not been discovered.

Igneous rocks are, however, rich in fissures in which, according to the theory of Mendeleef, petroleum must have accumulated, as well as in the fissures of sedimentary formations. Now the fissures of the first never contain hydro-carbides in notable quantity. Even the inexperienced mining engineer is so well aware of this fact that he does not undertake a boring in rocks of this nature. Whence comes this preference of petroleum for sedimentary lands? In my opinion, it proceeds from only one cause. Petroleum is indigenous in formations where it is found in large quantity.

The theory of the geologists may therefore be adopted with confidence. The hypothesis, based on the purely organic and progressive genesis of mineral oils, justifies the conclusion that formations rich in marine fossils are alone producers of petroleum, and that they all may be such. Care must therefore be taken not to attribute petroleum bearings to one or other of these strata to the exclusion of all others according to the needs of any theory. On the other hand, it would be dangerous to consider all sedimentary lands as producers of petroleum (even if *impregnated*) for physical reasons easily determinable.

The lands richest in petroleum, the lands not only impregnated, but producers, would be theoretically the marine sediments the richest in elements of nonfibrous organic decomposition.

In the geological system of the old continent, with rare exceptions, this supposition is confirmed by experience. The tertiary formations are the grand reservoirs of petroleum, and in the tertiary formations it appears that the base especially must be considered as productive. At Bakoo and in Galicia, that is, in the two richest deposits of Europe, petroleum is found in large quantity in the eocene and the nummulitic.

In Algeria, where the geologic system corresponds to the formation of the Alpine, Carpathian and Caucasian basins as to the period of upheaval, this is for us, an indication that petroleum must be met with in the same strata.

* From the French of M. Henri Neuburger, Summary of Communication to the Petroleum Congress.

† The opinion of M. Neuberger on the formation of petroleum was admitted by the Congress as official.

EMPLOYMENT OF CHEMICAL PRODUCTS FOR THE DESTRUCTION OF WEEDS.

WHERE is the gardener who is not anxious to get rid of weeds in his alleys, which he endeavors to destroy as soon as they appear, especially after rainy days? If he does not pull them up very quickly, he knows that the paths will keep up a competition to see which will turf over the quickest. To war against this untimely vegetation, he has only to put under contribution certain chemical products, the sulphates of copper and iron, or even sea-salt. This is confirmed by recent experiments of the Messrs. Nasier, which are described in the Lyon Horticole.

M. Paul Noël, the learned director of the laboratory of agricultural entomology at Rouen, to whom we are indebted for so many efficacious remedies against larvæ and cryptogamous germs which at times infest our fields, trees and flowers, has recommended tar oil (mineral) mixed with water and well emulsioned, in the proportion of 50 per cent. It appears that the copious sprinkling of this mixture with the watering pot in the paths, in court yards, and under casks, will prevent the grass from appearing for two years. The defect of this simple process is its cost and the disengagement for a week of an odor that is not very pleasant.

Sea-salt has been advised by the horticulturist, M. C. Wendelen, for destroying the thistle, that rustic plant unparalleled as the cause of despair for gardeners. It is in vain to cut it, or to pull up the stalk, for it at once springs up again from the roots. After useless struggle, M. Wendelen applied the salt; this was effectual. The plants fell sick, and in three days their heads drooped; in less than two weeks they expired, and there has been no resurrection.

The salt not only attacks the thistle, but also horsetail, bind weed and other parasitic plants.

The sulphates of iron and copper have also been attended with remarkable effects. The palm unquestionably belongs to the iron sulphate. It is the most efficacious and costs the least. It is now employed on a large scale for preserving vines and cereals from the invasion of the charlock and the wall flower, and is effectual for destroying injurious plants of all kinds, not omitting the thistle.

As the result of repeated experiments, M. Geschwind advises the addition generally of a little sodium nitrate to the iron sulphate. He has prepared the following formulas which meet requirements, according to the soil:

1. Iron sulphate, 10 kilos; sodium nitrate, 1.5 kilos.
2. Iron sulphate, 5 kilos; sodium nitrate, 3 kilos.
3. Iron sulphate, 25 kilos.
4. Iron sulphate, 20 kilos.

The quantity indicated in each formula is for a hectoliter of water; five or six hectoliters are required per hectare.

According to the Messrs. Nasier, the corrosive liquid should be prepared in the following way: Heat water to a sufficiently high temperature, cover with a piece of an old sack or other cloth the salts to be employed, and hang the package in the hot water by means of a string. When the salts are dissolved, add the quantity of cold water necessary to bring the liquid to the proportion of the quantity of the salts, and sprinkle the liquid by means of a sprayer. Care should always be taken to stir the liquid before filling the sprayer. The vessels used should afterward be carefully rinsed to prevent any attack of remaining acid:—Translated from Le Phosphate.

MOSQUITOS AND COLOR.

IT is now fairly established that members of the family Culicidæ, gnats and mosquitos, are the chief if not the only conveyers of malaria, yellow fever, and many of those diseases grouped together under the term Filariasis. About the last-named group there is still much to learn, although its conveyance by the mosquito was the first of the three to be demonstrated. It is also fairly established that, by precautionary measures, such as the destruction of the breeding-places of mosquitos in the vicinity of inhabited areas, whole towns may be rid of these pests and the health of the inhabitants correspondingly improved. The Americans have cleared Havana of its mosquitos, or, at any rate, have reduced their numbers by 90 per cent; and, as Surgeon Gorgas reports, "for the first time since 1762 Havana has been free from yellow fever in October," while the cases of malaria have been reduced to less than one-half. From time to time the Liverpool School of Tropical Medicine remind the public of the work they are doing in the same direction. Quite recently under their auspices a distinguished Cambridge graduate, Dr. Balfour Stewart, left for the Gold Coast to take part in this work; and only a few days ago Sir Alfred Jones assured a Liverpool audience that certain places on the West Coast had for the first time in his recollection been free from yellow fever. Thus it is evident that much may effectively be done to rid whole townships of these malignant pests; but it is otherwise with the open country and the primeval forests. Here it is hopeless to expect to exterminate the mosquito; and here the explorer, the sportsman, the pioneer, the missionary must go. The question as to whether any precautions can be taken to protect such travelers is one worthy of attention, and some experiments which were carried on last summer at Cambridge seem to point to at least one means by which the attacks of the mosquito may be lessened or avoided.

In continuation of their researches on the structure and biology of Anopheles maculipennis, the commonest British mosquito and one known to convey malaria, Dr. Nuttal and Mr. A. E. Shipley observed some interesting facts on the preference this species exhibits for different colors and for different shades of color. The experiments were conducted as follows: In a spacious photographic studio a large muslin tent was set up with one end against the glass window through which the sunlight poured. At the bottom of the tent were some large pans for the anopheles to breed in, and these were from time to time renewed. The mosquitos were fed on bananas—which, it may be noted, must be kept fairly fresh, otherwise dates or figs are preferable. On one side of the tent 17 boxes without lids were piled one upon the other, the order being changed each day so as to eliminate any preference due to position or exposure to light. Each box was lined with a cloth having a slightly rough surface, not a shiny or smooth one, to which a mosquito could easily cling. The experiment consisted in counting the number of mosquitos found in each box on 17 different days. The results obtained were striking. During the 17 days on which the count was made 108 mosquitos were found in the navy blue box, 90 in the dark red box, 81 in a reddish brown box, 59 in the scarlet box, 49 in the black box. There was at this point a sharp drop of 31 in a slate gray box and 24 in an olive green box. Violet, leaf green, and full blue boxes had respectively 18, 17, and 14. Pearl gray had nine, pale green four, light blue three, ocher and white two each, orange one, and pale yellow about the color of khaki none at all.

It is evident that color has a marked power of attracting this species of mosquito and that the color which is by far the most attractive is navy blue. In both services and equally among civilians this is a very common, perhaps the commonest, color for male attire. The experiments just quoted show that it is at least equally popular with malaria-carrying mosquitos. Light colors were avoided, especially those with a tinge of yellow. Khaki-colored garments would seem to have other advantages besides that of invisibility on a light soil.

The results of these observations, conducted on one species and in the midst of an English university town, must not too rashly be thought to hold good of other species living in the open; but there is a certain amount of evidence that points in the same way. It has been noticed in Indian hospitals that anopheles hide on black coats and avoid white ones, so that the men who catch them take care to hang up a dark coat or two in the wards when they wish to collect the insects. The Frenchman Joly noticed in Madagascar that the mosquitos were attracted by a black soil more than by a red or light one, and that persons wearing black shoes and socks were more often bitten than those who wore white or light coverings for their feet. While a black dog was severely bitten, its companion, who was yellow, almost entirely escaped—thus the "yaller dog" of Western fiction has some advantages in this world.

...ier observations not only point to a modification dress in malarial districts, but they indicate that much may be done to render dwelling houses and temporary shelters less habitable to the insects. Mr. J. Cropper has put on record how attractive the dark blue lining of the tent he used in Palestine was to anopheles and to other Culicidæ, and Austen has noted that if the walls of a room be whitewashed with a dark dado the insects are invariably found on the dado and not on the light surface. This points to doing away with dados and using only whitewash.

The gist of these experiments, which seem to have a very practical bearing on life in malarial districts, was published in the British Medical Journal last September. They seem to have attracted little attention in this country; but the practical minds at the head of the United States army, without waiting for the fuller report which apears in the current number of the Journal of Hygiene, have already decided to take action on the lines that the experiments indicate. We learn from the Surgeon-General's office in Washington that the regulation army shirt of navy blue is to be withdrawn from all malarial districts and a light one issued in its stead.

THE BURSTING OF SMALL CAST-IRON FLY-WHEELS.*

By CHARLES H. BENJAMIN, Cleveland, O., Member of the Society.

1. IN November, 1898, the writer read a paper before this Society on the subject of small fly-wheels, detailing the results of some experiments made in the laboratories of the Case School.

The discussion of the former paper and suggestions received from various engineers since its publication, have led to further experiments on wheels of peculiar design. These experiments were all conducted under the immediate direction of the writer, and he was present at most of the destructive tests.

2. The wheels numbered 1 to 9, inclusive, were tested during the winter of 1899-1900 by senior students Messrs. Clyne and Mühlhaüser; while those numbered 10 to 16 were tested during the present year by Messrs. Austin, Mills, and Stanford, instructors in the school. The wheels were all of cast iron, 24 inches in diameter, with proportions copied from existing wheels.

The general method of testing was similar to that used in the former experiments, but new apparatus was designed and built for greater convenience and safety.

3. Former tests had shown the insecurity of a wooden shield or cage for the bursting wheels. Fig. 1 shows the form of shield used in the later experiments. A cast-steel ring 36 inches in diameter inside, and having a rim section 4 inches by 6 inches, was inclosed and supported by a wooden framework, the front and back being of oak plank, 3 inches thick. To absorb the energy of the flying fragments a sectional lining of Norway pine was used, as this could be easily repaired and renewed after each test. Fig. 2 shows the usual appearance after an explosion. During the sixteen experiments recorded, but one wheel managed to escape from the shield, and this was due to the breaking of the bolts confining the side planking.

The wheels were keyed to the overhanging end of a steel shaft, 1 7-16 inches in diameter, running in a long bronze bushing and coupled loosely to a Dow steam turbine. Fig. 3 shows clearly the rear of the shield and the connections.

As may be seen from the cut, the speed was measured by means of a counter-shaft and belted tachometer, the speed being reduced in the ratio of one to ten. Belts made of two thicknesses of adhesive electric tape stitched together were found to be satisfactory at the speeds used, being free from slip.

The speed-counting mechanism was calibrated many times, and showed an error of less than 1 per cent.

All of the wheels tested were balanced carefully by winding lead wire around the arms, close to the rim.

4. Wheels Nos. 1 and 2 were cast with solid rims, and were modeled closely from a fly-wheel 10 feet in diameter on an Allis engine. These were tested to furnish a standard of comparison for the other wheels. Fig. 4 shows the shape and proportions of this class, and Table I. gives the principal dimensions.

These two wheels failed at 3,700 and 3,850 revolutions per minute respectively, or at an average rim speed of 395 feet per second. This corresponds to a centrifugal tension of about 15,600 pounds per square inch. The fracture showed clean iron of a uniform quality.

The four wheels numbered from 3 to 6 each had two

TABLE I.

DIMENSIONS.

No.	Rim.				Arms.		Weight of Wheel, Pounds.
	Diam., Inches.	Breadth, Inches.	Depth, Inches.	Area, Sq. In.	Number.	Area, Sq. In.	
1	24	4.06	0.85	3.95	6	1.08	97.2
2	24	4.10	0.80	3.65	6	1.08	94.7
3	44	4.00	0.84	3.73	6	0.95	94.0
4	24	4.00	0.84	3.73	6	0.95	91.7
5	24	4.00	0.84	3.73	6	0.95	95.0
6	24	4.00	0.84	3.73	6	0.95	96.0
7	24	2.22	2.23	4.43	8	1.67	123.0
8	24	3.00	2.50	2.46	24	0.049	60.5
9	24	3.00	2.50	2.46	24	0.049	60.5
10	24	4.03	0.80	3.67	6	0.98	96.5
11	24	4.02	0.80	3.59	6	0.92	97.0
12	24	4.02	0.80	3.59	6	0.92	95.7
13	24	4.06	0.83	4.08	6	0.92	114.5
14	24	4.06	0.82	4.08	6	0.92	116.0
15	24	4.10	0.56	2.90	6	0.95	88.0
16	24	4.09	0.57	2.92	6	0.95	87.0

TABLE II.

FLANGES AND BOLTS.

No.	Flanges.			Bolts.		
	Thickness, Inches.	Net Breadth, Inches.	Net Area, Sq. Inches.	Number in Joint.	Diameter, Inch.	Total Tensile Strength.
3	1.0	2.4	2.4	4	.375	20,000
4	1.0	2.4	2.4	4	.375	20,000
5	1.0	2.4	2.4	4	.375	20,000
6	1.0	2.4	2.4	4	.375	20,000
10	1.0	2.4	2.4	4	.375	20,000
11	1.0	2.4	2.4	4	.375	20,000
12	1.0	2.4	2.4	4	.375	20,000
15	⅝	1.9	1.2	2	.500	18,000
16	⅝	1.9	1.2	2	.500	18,000

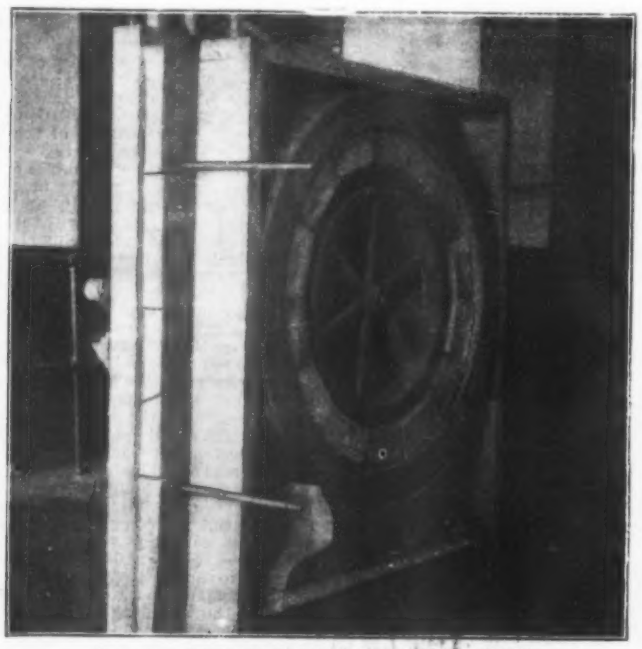


FIG. 1.—TEST CASING FOR FLY-WHEELS.

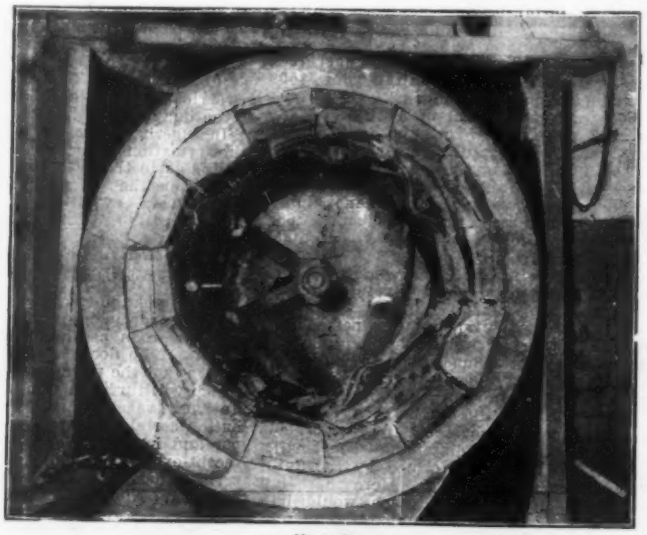


FIG. 2.

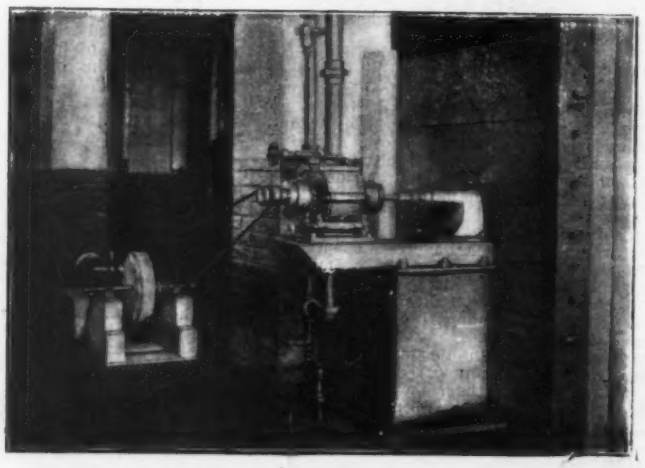


FIG. 3.—DRIVING APPARATUS FOR FLY-WHEELS.

FIG. 4.

FIG. 5.

* Presented at the New York meeting (December, 1901) of the American Society of Mechanical Engineers, and forming part of Volume XXIII. of the Transactions.

flanged joints in the rim, as shown in Fig. 5. These joints were of the same general proportions as those described in the previous paper, as may be seen by reference to Table II. At the suggestion of Mr. Jas. B. Stanwood, of this Society, they were located at points one-fourth of the distance from one arm to the next, those being approximately the points of least bending moment.

As shown in Table III., these wheels burst at from 1,800 to 1,900 revolutions per minute, or an average rim speed of 194 feet per second. This corresponds to a centrifugal tension of about 3,750 pounds per square inch.

These wheels were, then, only one-quarter as strong as similar wheels with solid rims, and burst at one-half the speed. Comparing these with wheels of similar construction tested in 1898 (Nos. 13, 14, and 15 in the previous paper), we find that moving the joint from the center to the quarter point has made no appreciable difference in the strength.

This is, doubtless, due to the fact that the heavy mass of the flanges and bolts locates the bending moment at or near them. "Where MacGregor sits, there is the head of the table."

5. Fig. 5 shows the general manner of fracture of these wheels; strange to say, the joints usually remained intact—the bolts being slightly stretched—and the rim broke close to the joint, as shown in the cut.

6. The practically instantaneous character of the explosion is illustrated in Fig. 6, which shows the appearance of wheel No. 6 after rupture. With but one exception, each piece of the rim was embedded in the wood lining in its proper place and remained there, indicating an early simultaneous movement of the fragments. The lining was rotated in the steel ring through a considerable angle.

The combined tensile strength of the bolts in the flange joints was about 20,000 pounds, or less than one-third the strength of the solid rim, which is about the maximum ratio possible with this style of joint.

7. Wheel No. 7 was a complete working model of a fly-wheel for a blowing engine, and was copied from drawings furnished by a well-known firm of engine builders. The construction is clearly shown in Fig. 7, and the dimensions are given in Table I. The joints in the rim were carefully fitted and the links shrunk in. This wheel burst at 2,450 revolutions per minute, and a rim speed of 256 feet per second, which indicates a centrifugal tension of about 6,600 pounds per square inch, and shows that this wheel is nearly twice as strong as those just described. As may be seen by reference to Fig. 8, the wheel broke in every instance through the smallest section of the rim near the joint, the links remaining intact. It is interesting to note that every bolt in the hub was shaved off clean as by a knife, each arm pulling out in this way.

8. Soon after the publication of the previous paper, the writer had some correspondence with Prof. Archibald Sharp, of London, Eng., which resulted in the latter's sending to this country two model wheels to be tested, which are numbered 8 and 9 in the tables, and were constructed as shown in Fig. 9. The rims were solid, of an I section, and were made of a close grained cast iron having a high tensile strength.

Each wheel had 24 spokes of steel wire, 12 on each side of the central plane. A pair of spokes constituted a loop, fastened at each end to the rim with a thread and nut, and passing spirally around the hub in a groove cut for that purpose. By tightening up the nuts at the rim the wheel could be accurately centered, and sufficient friction caused at the hub to prevent slipping.

The two wheels failed at precisely the same speed, 4,050 revolutions per minute, or a rim speed of 424 feet per second. This would correspond to a centrifugal tension of nearly 18,000 pounds per square inch, and is probably the maximum speed attainable with a cast-iron rim. The appearance after rupture is shown in Fig. 10.

The rims usually broke through the holes where the spokes were fastened, and the spokes themselves broke at one or both ends, where threaded.

The spokes had been adjusted to a uniform tension before the test by "tuning" them to the same pitch. This uniformity of tension, and the large number of spokes, must have prevented any serious bending of the rims, so that the latter failed by direct tension.

The speed given is the highest attained in any of the experiments. One fact in connection with this last experiment deserves mention. It was found impossible at first to bring these wheels up to the desired speed; at about 3,000 revolutions per minute the speed would remain constant, and no increase of steam pressure would avail to change it. Becoming convinced that this was due to air resistance on the spokes and cross flanges of the rim, the writer had the wheels inclosed by disks of Russian iron, wired together and revolving with the wheels. No further difficulty was experienced, and the bursting speed was attained within two minutes of the time of opening the throttle.

Similar devices had to be used with wheels numbered 13 to 16, inclusive.

9. Wheels numbered 10, 11, and 12 had the usual flanged joints, located midway between the arms and fastened with four ⅞-inch bolts. The joints in wheel No. 10 were unsupported, while those in wheels Nos. 11 and 12 were strengthened by steel tie rods running from hub to joints and bolted at each end, as shown in Fig. 11. The net tensile strength of each tie rod was about 5,000 pounds. The two rods connected to each joint had then a combined tensile strength about two-thirds that of one arm. Wheel No. 10 burst at 1,570 revolutions per minute, a rim speed of 164 feet per second, which is only about five-sixths of the speed usually attained by this class of wheel. The break was in the rim just beside the flange, and the low speed would indicate a poor quality of iron.

10. Wheels Nos. 11 and 12 broke at 2,100 and 2,200 revolutions per minute, respectively, or at an average rim speed of 225 feet per second. Comparing these with wheel No. 10, as the three wheels were of the same iron and identical in every respect save the tie rods, we find an increase of from 34 to 40 per cent in the bursting speed due to the use of the tie rods. This corresponds to an increase of nearly 100 per cent in the strength of the joint. If the tie rods had been more carefully designed and constructed, a greater speed could have been attained.

Fig. 12 shows the appearance of wheel No. 12 after rupture. The ties broke through the bolt holes at one or both ends, the bolts remaining intact with but one exception.

11. Wheels Nos. 13 and 14 were of peculiar construction, as may be seen from Fig. 13. The rim of each was cast in one piece, while the hub and arms formed a spider, also in one casting. The arms were jointed to the internal flanges of the rim by ⅝-inch steel bolts, giving one degree of freedom. The object of this construction was two-fold:

First.—To relieve the bending moment at the junction of the arm and rim.

Second.—By concentrating more weight near the arms to stretch these latter and thus relieve the bending moments in the rim midway between the arms.

These two wheels burst at 3,650 and 3,850 revolutions per minute, or an average rim speed of 392 feet per second. Comparing these figures with those given for wheels Nos. 1 and 2, we find that the speeds are practically the same. There is no apparent advantage in the special construction just described over the ordinary method of casting the spokes and hub with the rim.

Fig. 13 shows the appearance of wheel No. 13 after rupture. The arms all broke at the eye near the rim, the bolts not being injured. Only one web was fractured. Fig. 2 shows the wheel immediately after the explosion, the front of the shield and one cover plate being removed. The embedding of the rim fragments in the wood lining in their proper order is clearly shown, the same as in Fig. 6. The absence of any tearing or rending sound and the single sharp report, like a small cannon, also evidenced the practically instantaneous character of the explosion.

Wheel No. 14 was the one which escaped from the shield, as has already been noted. The wood lining was reduced to fine splinters, the cast-steel ring, weighing over 800 pounds, was rotated through an arc of 12 inches, a ¾-inch bolt was broken short off, and the 3-inch oak planking split and torn.

12. Wheels Nos. 15 and 16 were also of special construction, as seen in Fig. 14. The hub and arms were cast together as a spider and bolted to pads on the rim. The two joints in the rim came over arms, and the rim between the arms was reinforced by elliptic webs. The construction is a slight modification of that suggested by Mr. A. J. Frith, of this Society, in a paper read in December, 1899.* The *raison d'être* of this form of wheel is explained by Mr. Frith in his paper. Briefly, this construction is intended to stretch the arms more and bend the rim less than the common form.

These two wheels burst at 2,080 and 2,175 revolutions per minute, respectively, or an average rim speed of 223 feet per second. Fig. 14 shows the manner of failure. The ends of the arms failed in several different ways: sometimes it was the screws that broke, sometimes the lugs on the arm, and sometimes the pad on the wheel. The rim usually broke at points midway between the arms. In wheel No. 16 the joints remained intact.

It will thus be seen that Nos. 15 and 16 were of practically the same strength as Nos. 11 and 12, but only

*No. 839, vol. xxi., p. 317.

TABLE III.

BURSTING SPEEDS.

No.	Bursting Speed.		Centrifugal Tension.	
	Revolutions per Minute.	Feet per Second.	Pounds per Square Inch.	Total on Rim.
1	3,700	287	14,980	59,000
2	3,850	403	16,240	59,000
3	1,800	188.5	3,570	13,560
4	1,850	193.6	3,750	14,000
5	1,900	199	3,950	14,780
6	1,850	193.6	3,750	14,000
7	2,450	256.5	6,600	29,400
8	4,050	424	17,970	44,000
9	4,050	424	17,970	44,000
10	1,570	164	2,700	9,920
11	2,100	220	4,800	17,200
12	2,200	230	5,300	19,000
13	3,650	382	14,600	59,600
14	3,850	403	16,300	66,500
15	2,080	218	4,800	13,900
16	2,175	228	5,200	15,200

FIG. 6.

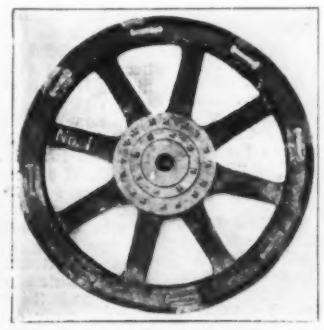


FIG. 7.

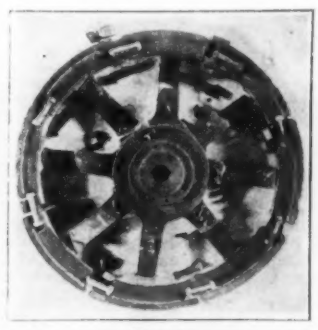


FIG. 8.

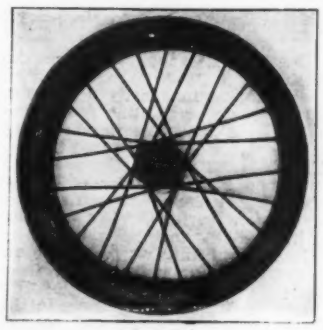


FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

FIG. 13.

FIG. 14.

about one-third as strong as wheels with solid rims.

13. The conclusions of the previous paper are confirmed by these further experiments. For wheels of moderate size correctly proportioned the solid rim is by far the safest form, and will require a speed of from 350 to 400 feet per second to produce rupture. The stress due to bending is so small as to be negligible.

Jointing the arms at the rim and bracing the rim by internal webs have no important effect on the strength.

Joints in the rims are the principal source of weakness, especially if located between the arms. Probably no joint can be made for a rim of solid cross-section which will be more than one-third as strong as the rim itself.

Hollow rims will permit of a much more efficient joint, as has been shown by Mr. John Fritz in his paper, read at the meeting of this Society in May, 1899.*

The joints in Mr. Fritz's wheel are practically as strong as the rest of the rim. This construction is hardly possible in wide-faced band wheels such as are used on most shop engines. Joints similar to those shown in Fig. 14 are probably the best that can be devised for this type of wheel. If joints are located midway between the arms they should be reinforced by tie rods leading to the hub.

The English wheels, Nos. 8 and 9, show clearly the advantage of numerous arms on any type of wheel. Even if the rims were jointed, such wheels would prove their superiority to those with the ordinary arms in maintaining their shape at high speed.

A CENTURY OF PROGRESS IN ACOUSTICS.†

IN selecting the "Progress of Acoustics," on its experimental side, as the subject for this year's presidential address, I am fully alive to the fact that this branch of science has been comparatively neglected by physicists for many years, and that consequently I cannot hope to arouse the interest which the choice of a more popular subject might command. It is, however, just because of this neglect of an important field of science that I conceive it to be my duty to direct some attention thereto. This duty I can best perform, it seems to me, by taking a survey of the work accomplished in this particular field during the century that has just closed. Such a survey will make it evident not only that the science of acoustics has made immense progress during that time, but also that many of the experimental methods in use in other branches of physical science were invented and first employed in the course of acoustical research. This latter fact, though not generally recognized, furnishes an illustration of the interdependence which exists between the various branches of physical science, and suggests the probability that the work of acoustical research in the future may be advanced by experimental methods specially designed for investigation in other fields. A revival will, of course, come in time for acoustics, as it has recently come for electricity, and it ought to come all the sooner because of the co-operation which physicists may naturally look for from those who are cultivating the new fields of experimental psychology.

In order to avoid the tedium of a bare enumeration of discoveries arranged chronologically, I propose to refer in the first instance to the invention of the various experimental methods which have been employed in acoustical research. A separate reference to these methods will enable us to appreciate their potency in the advancement of this science.

The earliest of these methods is due to Chladni, whose work, "Die Akustik," appeared in the form of a French translation in 1809, under the title "Traité d'Acoustique de Chladni." In this work were collected all the researches on the vibrations of bodies which Chladni had conducted with the aid of the new method (méthode de sable). This method consists in distinguishing, on the surfaces of vibrating bodies, the parts which are vibrating from the parts which are in repose, by means of the sand which is driven from the former to collect on the latter. In these experiments of Chladni on plates, etc., the violin bow was used for the first time to produce the necessary vibrations. The bow had previously been used only for vibrating cords, the "violon de fer," and other musical instruments. Chladni made his discovery of sand figures in 1787, having been led thereto by Lichtenberg's discovery of electric figures.

The transversal nodal lines given by Chladni's method in the case of rods vibrating longitudinally were readily explained. Not so, however, the complicated nodal lines presented by vibrating plates, or the alternate lines which appear on the two sides of rods vibrating longitudinally, and which sometimes also appear on rods vibrating transversally. It was not until 1833 that an explanation of the former of these phenomena was offered by Wheatstone's theory that the nodal lines were due to the superposition of transversal vibrations, corresponding to sounds of the same pitch coexisting with respect to different directions in the plate. This theory was confirmed experimentally in 1864 by Rudolph Koenig, who constructed rectangular plates giving unison notes corresponding to different sets of nodal lines parallel to two adjacent sides of the plate. The theoretical figure results when the plate is vibrated so as to produce the coexisting unison notes.

The alternate nodal lines given by vibrating rods were also explained by the theory of the coexistence of two sounds near unison in the same vibrating rod. In this case, however, one sound corresponds to longitudinal, and the other to transversal vibrations. This explanation was first given by Augusta Seebeck in 1849, whose theory was confirmed in 1859 by Terquem in a very important paper "Sur les vibrations longitudinales des verges libres aux deux extrémités."

In 1807, five years after the publication of Chladni's "Akustik," appeared Dr. Thomas Young's "Course of Lectures on Natural Philosophy and the Mechanical Arts" in which we find the earliest description of the graphical method, including its application to chronography. This description is as follows:

"By means of this instrument we may measure, without difficulty, the frequency of the vibrations of sounding bodies, by connecting them with a point which will describe an undulated path on the roller. These vibrations may also serve in a very simple manner for the measurement of the minutest intervals of time; for if a body, of which the vibrations are of a certain degree of frequency, be caused to vibrate during the revolution of an axis, and to mark its vibrations on a roller, the traces will serve as a correct index of the time occupied by any part of the revolution, and the motion of any other body may be very accurately compared with the number of alterations marked, in the same time, by the vibrating body." Notwithstanding the clearness of this description, the graphical method remained for a long time unknown, and when it was developed later, in 1862, the original discovery was incorrectly attributed to Wilhelm Weber (1830). Between these dates slight applications of the method had been made by Savart, Duhamel, Lissajous and Desains, Wertheim, and others; the most important of such applications being that of Scott, who in 1858 applied it to his phonautograph. Finally, from 1858 to 1862, Rudolph Koenig devoted himself specially to the perfecting of this method, and exhibited the results of his labors at the Exhibition in London in 1862, in the form of a large collection of phonograms. This collection in its seven sections comprises all the applications of the method which have so far been made in acoustics. While the progress of this method was thus slow before 1862, its use from that time onward became general, especially in physiological researches, in connection with which it received its widest development in the publication by M. Marey of his splendid work, "La Méthode Graphique" in 1878. Parenthetically I might remark that Edison's phonograph (1877) was doubtless suggested by Scott's phonautograph.

As with the graphical method, the earliest suggestion of an optical method of studying vibratory movements came from Dr. Thomas Young, who in 1807 gave the construction of curves resulting from the composition of two rectangular vibratory movements. The practical realization of these curves was effected in 1827 by Wheatstone in his kaleidophone. The most important advance, however, in the development of this method was made by Lissajous, who, after some preliminary work in 1855 published in 1857 his great paper entitled "Mémoire sur l'étude optique des movements vibratoires." The optical effects produced by Lissajous' method, especially when the curves were projected on the screen, were so beautiful that the method obtained general recognition, and became immediately popularized. The chief merit of the method, however, does not lie in the beauty of the effects thus obtained, but rather in the fact that by this means we are enabled to determine with facility and with the utmost accuracy both the interval and the difference of phase between two vibratory movements. It is this fact which renders the optical comparator one of the most important instruments at the disposal of the acoustician.

A second optical method we owe to Biot, who in 1820 showed that the changes in density at the nodes of a transparent body vibrating longitudinally could be exhibited when the nodal line of the body is placed between the crossed mirrors of a polarization apparatus. During the continuance of the vibrations the image is highly illuminated in the analyzer and becomes darkened when the vibrations stop. This method was developed much further by Kundt in 1864, and by Mach in 1873.

A third optical method was devised by Toepler and Boltzmann in 1870 for the purpose of exhibiting the changes which take place at a nodal point of a vibrating column of air. This method consists in producing interference bands by means of two rays of intermittent light from the same source, one of which passes through the air in its normal state, and the other through a nodal point of the vibrating air column. A vibratory movement of the interference bands results—a movement which can be made as slow as we please, thus rendering it possible to deduce by stroboscopic methods exact measurements as to the movement of the air at the nodal point.

The object of the method of manometric flames, invented by Rudolph Koenig in 1862, is to furnish an ocular proof of the variations in density at a point of the air traversed by waves originating in another body or in the air itself. A short description of the first apparatus based on this method appeared in Poggendorff's Annalen in 1864. Between that year and 1872 the method was applied to a series of instruments, the experiments being described in the same journal in a long memoir entitled, "Les flammes manométriques." Although this method is extremely sensitive and capable of furnishing very accurate results, it has been prevented for a long time from rendering more efficient service on account of two causes: First, the want of sufficient brightness in the reflected images of the jumping flames, and, second, the difficulty of observing the details of these images owing to their momentary appearance in the mirror. The former of these difficulties has now been overcome by the employment of acetylene and other gases, which at the same time allow admirable photographs of the flames to be taken, thus obviating the second difficulty also. We owe an important paper on this subject to Profs. E. L. Nichols and Ernest Merritt published in 1898 in the Physical Review.

In 1865, Kundt published his method of using light powders for the purpose of exhibiting the vibratory character of stationary air waves in columns and plates of air. During the existence of these vibrations the light powders arrange themselves in transversal striæ which collect around the loops, and are wanting at the nodes. As in the case of the nodal lines on Chladni's plates, a satisfactory explanation of these striæ was for a long time wanting. In 1890 Prof. Walter Koenig showed, from hydrodynamical considerations, that the particles of the powder necessarily arrange themselves in planes at right angles to the direction of the vibratory movements, and that their observed distribution at the loops and nodes is in accordance with the same laws.

Before the invention of the preceding methods the acoustician occasionally resorted to the device of deducing the vibrations of a sounding body from the behavoir of a similar body whose movements were of sufficient amplitude to be seen by the eye, and so slow that they could be readily counted. In this way Mersenne counted the vibrations of a cord 15 feet long under a stretching force of 7 pounds, and found them to be 10 per second. In shortening the cord to one-twentieth of its length, he obtained an audible sound whose pitch, he concluded, corresponded to 200 vibrations per second. In the same way Chladni employed a long and thin metal rod, which gave in the first instance only 4 vibrations per second. He then shortened the rod until it gave an audible sound whose pitch he determined from the law expressing the relation between the length and the number of vibrations. This method, however, which appears so simple in theory, is subject to large errors and gives in practice very poor results.

Mersenne's and Chladni's method has accordingly given place to another—the stroboscopic—which allows the vibrations of the sounding body to be viewed directly, its movements relatively to a vibrating eyepiece being rendered as slow as we please. The first use of stroboscopic disks for the purpose of observing very rapid periodic movements was made by Plateau in 1836. His discovery, however, remained unnoticed, for Doppler, in 1845, published a note on the same subject, without referring to Plateau's discovery. It was Toepler who first made the method generally known by employing it in a series of acoustical experiments which he published in Poggendorff's Annalen, Vol. 128. In the earlier applications of this method, the view of the vibrating body was rendered intermittent by looking through slits which were opened and closed in rapid succession. This plan was modified by Mach, who caused the vibrating body to be illuminated by intermittent light.

If now we allow the stroboscopic images of a moving body to fall on a photographic plate, giving the plate a movement of translation which is arrested before each appearance of the image, we thereby obtain a series of photographs of the successive positions assumed by the body. If, further, matters are so arranged that the beginning and duration of the phenomenon are traced on the images, we have a new method, which is called chronophotography. It was M. Janssen who first conceived the idea of taking automatically a series of photographic images in order to determine the successive positions at different times of the planet Venus in its passage across the sun. It was Janssen also who, in 1876, first suggested the idea of applying successive photograms to the study of animal locomotion. The analyzing of such movements was first accomplished by Muybridge, of San Francisco. The method has been largely extended and perfected by M. Marey, who has employed it in studying the locomotion of all sorts of subjects, from men to insects.

The last of the methods to be noticed is that employed by Rudolph Koenig in his wave-siren. In this instrument a metal band or disk with curvilineal edges passes before a narrow slit from which issues a current of compressed air. By means of these disks we can produce either simple sound, or sounds of various timbres, containing such harmonics as we please, the intensities and phases of the latter being varied at will. The first wave-siren was constructed in 1867, and the account of the first series of experiments was published in 1881.

The mere enumeration of the methods of acoustical research which have been devised since the days of Chladni is an indication of the enormous advances which have been made in this branch of science. It remains now to state more particularly what these additions to our knowledge of acoustical phenomena have been. This can be most conveniently done under the following heads, viz.: The velocity of sound; its pitch, intensity and timbre; and the phenomena produced by the coexistence of two or more sounds.

THE VELOCITY OF SOUND.

Long before the beginning of the last century it had been observed that the propagation of sound was not instantaneous. Mersenne, in fact, had tried to estimate the velocity by experiments on echoes, and by counting the time which elapses between the flash of a gun and the report. The latter experiments were also repeated by Kircher as well as by the Academy of Florence in 1660. The same experiments were subsequently, in 1738, undertaken by members of the Academy of Sciences at Paris, by savants, such as Kaestner, Benzenberg, Goldingham and others, but the results obtained did not gain the confidence of the scientific world. A new series of experiments was accordingly undertaken in 1822, on the suggestion of Laplace, by members of the Bureau des Longitudes, to determine the velocity in air and other media. These experiments, which were the beginning of truly scientific work in this subject, were performed by Prony, Arago, Mathieu, A. de Humboldt, Gay-Lussac and Bouvard, between Montlhéry and Villejuif, cannon being fired at both stations. The result obtained was 331 m. at zero temperature, with an increase of 0.6 m. for each degree above zero. In the course of these experiments it was observed that the cannon fired at Villejuif were all distinctly heard at Montlhéry, while the reciprocal reports were so faint that only a small number were heard. Tyndall long afterward, in 1875, explained this curious phenomenon, attributing it to the existence at Villejuif of a heterogeneous atmosphere, caused by the heated air which came from Paris.

Since the memorable experiments of the Bureau des Longitudes of Paris various individuals have from time to time undertaken to solve the same problem. Among these may be mentioned Moll and van Beck (at Utrecht), Gregory Woolwich, Stone and Capt. Parry in his voyages to the polar regions in 1822, 1824, and Kendall in the Franklin expedition in 1825. In some of these experiments the temperatures ranged from 2 deg. to —40 deg., the results obtained according with the theoretical values. In 1823 Stampfer and Myrback conducted experiments between two stations

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† Paper read before the American Association for the Advancement of Science.—From Science.

in the Tyrol at a difference of level of 1,364 m.; a similar experiment being undertaken in 1844 in Switzerland by Bravais and Martin with a difference of level of 2,079 m. Both experiments confirmed the law that the velocity of sound in air is independent of the pressure.

In all these experiments the exactness of the results was affected by the difficulty of estimating accurately the time between the perception of the flash and that of the report. Different observers, of course, gave different estimates. This source of error was first eliminated by Victor Regnault, who in his long series of researches between 1860 and 1870 made use of the graphical method and electric signals to measure time intervals. Regnault's experiments were conducted in seven tubes (part of the Paris sewers) varying in length from 70 m. to 4,900 m., and of diameters from 0.11 m. to 1.10 m. Experiments were also conducted in the open air by means of reciprocal shots fired from two stations at a distance of 2,445 meters. The number of shots fired was 334. These researches of Regnault represent such an enormous amount of work that I shall attempt to give only the principal conclusions deducible from them:

1. In a cylindrical tube the intensity of the wave varies, diminishing with the distance. The narrower the tube, the more rapid is the diminution.
2. The velocity of the sound decreases as the intensity diminishes.
3. The velocity approaches a limiting value, which is higher, the greater the diameter of the tube. The mean value in dry air at 0 deg. in a tube of diameter 1.10 m. is 330.6 m.
4. The velocity is not affected by the mode of producing the sound wave.
5. The velocity in a gas is independent of the pressure.
6. The ratio of the velocities in air and any other gas is $\sqrt{\frac{1}{\delta}}$, where δ is the density of the gas, supposed perfect.
7. The average of the results of all the experiments in the open air is 330.7 m. at 0 deg.

Regnault was also the first to attempt direct experiments for determining the velocity of musical sounds. In this case, however, the electric signals and the graphical recording apparatus were not sensitive enough to respond to the front of the wave, and it became necessary to resort to the ear alone. In these experiments Regnault had the co-operation of Koenig as observer, with whose assistance it was shown that:

1. A note does not change sensibly when it traverses long distances in tubes of large diameter.
2. When the sounds are observed by the ear the velocity of high notes appears to be less than that of low ones. This may be due to the more ready response which the tympanum makes in the case of low notes.
3. In traversing tubes of great length, a note does not preserve its timbre, being resolved into simple components.

Regnault's experiments have recently been repeated by M. Violle in the large sewers near Grenoble and Argenteuil, some of Regnault's apparatus being employed for the purpose. The results of these experiments have not, however, been yet published.

PITCH.

Before the last century, as already mentioned, Mersenne had attempted to determine the vibrations of a cord by deducing them from very slow vibrations of the same cord when lengthened. Chladni's tonometer, which consisted of a vibrating metal rod of variable length, was based on the same principle. In 1819 Cagniard de la Tour invented the siren, a much superior instrument, but incapable of giving very exact results, notwithstanding the simplicity of its mechanism. The same remark may be made of the toothed wheel invented by Savart in 1830.

A most important step in advance was made in 1834 by Henri Scheibler, of Crefeld, who in that year invented his tonometer, consisting of a series of 56 forks going from A (440) to its octave (880), the vibrations increasing regularly by differences of eight, any two adjacent forks thus giving four beats per second. Curiously enough, although Schiebler went to Paris and exhibited his tonometer there, he was unable to interest savants in his discovery; and it was not until the London exhibition of 1862 that the attention of physicists and musicians was directed to the value of the instrument by Koenig. The apparatus in its new form contained 65 forks going from C_3 (512) to C_4 (1024).

Notwithstanding the great utility of this tonometer to the acoustician, it still left undetermined the absolute pitch of the fundamental note, and hence of the whole series. This problem of realizing a standard of pitch remained practically unsolved, even after the French government in 1859 decreed that the standard should be A = 870 v. s., at 15 deg. C. The standard then constructed by Lissajous was found, in 1880, to be too high by nine-tenths of a vibration. The standard employed since 1880 by Koenig is C = 512 v. s. at 20 deg. The acoustical standard before that date was in reality 512.35 at 20 deg. The problem of realizing a standard fork, which had given rise to much controversy among physicists, was finally solved in 1880 by Koenig, who in that year published his paper "Recherches sur les vibrations d'un diapason normal." In this paper Koenig describes how by means of a clock-fork (horloge à diapason comparateur) he established a standard fork, the error of which did not exceed one six-thousandth of a vibration. The clock-fork method enables us at the same time to determine readily the variations in the number of vibrations due to a rise or fall of temperature. Having established in this way an absolute standard of C_3 = 512 v. s. at 20 deg. C., Koenig commenced the construction of a universal tonometer based thereon, a colossal undertaking which he finished in 1897, after working a score of years. This tonometer, which has a range from 32 to 180,000 v. s., consists of the following:

1. Four forks giving vibrations from 32 to 128, with differences at first of ½ v. s. and afterward of 1 v. s.
2. One hundred and thirty-two forks, tuned to give (without the sliders) the 127 harmonics of C_1, C_2, C_3, C_4, C_5, C_6, being in duplicate.

Each fork can be lowered, by means of sliders, to unison with the fork next below.

The differences immediately obtainable by sliders are:

One v. d. between C_1 and C_2; 2 v. d. between C_2 and C_3; 4 v. d between C_3 and C_4.

3. Forty resonators to reinforce forks of 2.
4. One large resonator of diameter 0.48 m. and of length varying from 0.30 m. to 2.30 m.
5. Eighteen forks for notes from C_1 to F_2.
6. Fifteen forks for notes from Sol_2 to 180,000 v. s.

Under the head of pitch come two very difficult questions relating to the audibility of very low or very high sounds. With regard to the former Helmholtz has shown that if the vibrations are very slow and do not follow the pendular law (the fundamental being thus accompanied by a series of harmonics), the fundamental may be quite inaudible, while the harmonic is heard distinctly. In such a case the harmonic is often mistaken for the fundamental. On the other hand, if we employ large tuning forks, vibrating rods, or the wave siren, for the purpose of obtaining pendular vibrations, we are still met with the difficulty of determining accurately the limits of audibility, owing to the fact that it not only depends on the intensity of the vibrations, but varies from one observer to another. In general it may be stated that it requires from 60 to 80 v. s. to produce a sound perfectly continuous and possessing a musical character. In using very powerful high forks to produce beats, which were gradually diminished in number, Koenig found that the sensation of a continuous low sound ceased when their number did not exceed 26.

As to the high notes above C_7 = 8,192, the amplitudes of the vibrations are generally so small that the ordinary methods no longer serve to determine the pitch. For this reason it was at first the practice to tune forks above C_7 by means of the ear. The high forks constructed by Marloye and presented to the Academy of Sciences at Paris, in 1848, by Depretz, were constructed in this way. In 1858, however, Koenig showed that even in the upper half of the octave C_6 to C_7, the best musicians ceased to judge the intervals accurately, a fact which seemed to show that it was extremely unlikely that forks giving notes two octaves higher could be tuned accurately by the ear. For this reason Koenig effected the tuning of very high forks by means of the sounds resulting from their beats. The first series of forks tuned in this way were made by Koenig in 1876. A set of similar forks constructed about the same time by Preyer, and going, as he alleged, as high as E_{10}, were shown by Melde, in 1894, to be greatly out of tune, the intervals being wrong by as much as a third, and even an octave. In 1897 Melde's results were confirmed by Stumpf and Meyer.

In 1899 Koenig published his researches on very high notes. In this memoir, after showing the exactness of the tuning attained by the sounds of beats in forks between C_7 and F_9, he proceeds to state that, by means of Kundt's method of using light powders, he had constructed a series of high forks accurately tuned and proceeding according to the intervals of the perfect (major) scale, from C_7 to the enormous pitch of 180,000 v. s., and that without reaching a limit to the number of such vibrations.

As to the audibility of these high forks, it has been remarked by Koenig that those between C_7 and C_9 are generally audible, while C_{10} and those above are entirely inaudible. He further remarks that the limit of audibility, which thus lies between C_9 and C_{10}, largely depends, as in the case of low sounds, on the intensity, and varies with the individual.

INTENSITY.

With regard to the question of intensity of sound, it is only necessary to say that there exists here a great lacuna in our acoustical knowledge, as we do not yet possess a means of measuring the physiological intensity of sound.

TIMBRE.

To Helmholtz belongs the credit of first elucidating the question of timbre by showing that the timbre of a sound depends upon the number and intensity of the harmonics accompanying the fundamental. The question of timbre is thus intimately connected with the study of the phenomena produced by the coexistence of two or more sounds. With regard to such phenomena, it was stated by Helmholtz that when the notes of different pitch are sounded together, they give rise to two other sounds, the pitch of which is measured, the one by the difference, and the other by the sum of the vibrations of the two primary sounds. Further, that these resultant sounds are not due to beats.

These propositions of Helmholtz are controverted by Koenig, who, on the contrary, has proved that the sounds actually heard accompanying two primary sounds are always due to beats. Koenig asserts, moreover, that the sounds referred to by Helmholtz, even if we could prove that they had a real existence, would always be inaudible, and therefore without effect on the acoustical phenomena. He further establishes the curious fact that even interruptions of a sound give rise to another sound.

As to timbre, Helmholtz's theory was that it depended solely on the number and relative intensities of the harmonics which accompany the fundamental, and that it is not affected in any degree by differences in the phases of these components. This latter proposition is combated by Koenig who holds that differences of phase as regards harmonics exercise a very important influence on the timbre of a sound, so that according to him timbre depends on the number, relative intensities and differences of phase of the harmonics which accompany the fundamental. Koenig's experiments on this disputed point were performed with his large wave-siren. Even this wider definition of timbre is, however, according to Koenig's most recent view and experiments, insufficient, as not being applicable to certain classes of timbres—for example, those produced by most musical instruments, especially stringed instruments. In these cases the fundamental is accompanied not only by harmonics, but also by other sounds which are not harmonics, the superposition of which produces series of waves which change their form successively. These wave forms have been investigated by Koenig in a paper, "Sur les timbres à ondes de formes variables," in which he determines the conditions under which such timbres may be considered musical, and concludes that in these cases the fundamental is accompanied by harmonics which continually change their relative intensities and their phase-differences.

In conclusion, I may state that, according to Koenig, the fact that differences of phase among harmonics produce differences of timbre is explained for the first time by his recent discovery that the intensity of a sound can be increased by the addition of another sound, when the maxima of intensity in the vibrations in the two cases correspond more or less exactly, and that several sounds produced together may reinforce a sound of lower pitch than any of them. For example, with the same six primary sounds, by changing their phases only, he produces not only timbres differing in intensity and in richness, but timbres in which, at one time, the octave (2) and at another time the fifth above (3) are heard. The difference between these two timbres is, indeed, so great that when heard in succession, there appears to be an interval of a fifth between them, although their fundamentals are exactly the same. These experiments may be said to be the last on this difficult subject in the years of the century which has just closed.

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PRINTING ROLLER COMPOSITIONS.

By A. LESLIE.

ROLLERS for transferring ink to types have to possess special properties, which have reference both to the nature of the ink and that of the types to which it is to be transferred. They must be as little liable as possible to changes of temperature. They must be sticky, but only just sticky enough, and must have elasticity enough to exert a uniform pressure over the varying surface with which they meet in the form. Originally, the composition was one of glue and treacle in varying proportions, and the only practical improvement that has been made is the addition of glycerine. This being slightly hygroscopic, helps to keep the roller at the right degree of softness, and being practically unfreezable, it is a great assistance in keeping the rollers from hardening in cold weather.

The invention of this composition, like many other valuable discoveries in connection with printing, is of very uncertain history. As late as 1813 Bacon and Donkin included a mixture of treacle and glue for printing rollers in a patent, but they expressly admit that the composition was at the time employed in printing on porcelain, and it is incredible that the discovery should be centuries posterior to the invention of metallic types.

The recipes given in technical works for printing roller compositions are very numerous, and very different. All, without exception, contain glue and treacle, and it is the practice to put a larger proportion of glue in rollers to be used in the summer than in those intended for winter use. The following is a selection of recipes:

1. Soak 8 pounds of glue in as much water as it will absorb. When there is no visible water, treat the glue till melted, and add 7 pounds of hot molasses.

2.	Glue (summer)	8 pounds
	Glue (winter)	4 pounds
	Molasses	1 gallon
3.	Treacle	12 pounds
	Glue	4 pounds
4.	Treacle	24 pounds
	Glue	16 pounds
	Paris white	2 pounds
5.	Glue or gelatine	64 pounds
	Water	48 pounds
	Linseed oil	96 pounds
	Treacle or sugar	64 to 96 pounds
	Chloride of calcium	3 pounds
	Powdered rosin	8 pounds

Soak the glue in the water and then liquefy by heat. Then stir in the oil, first heated to 150 deg. F. Then add the treacle and the chloride of calcium, and finally the fused rosin. The latter ingredient is only to be added when very tough rollers are required. This recipe is interesting from the inclusion in it of the hygroscopic salt, chloride of calcium, the object of which is obviously to keep the rollers moist.

6.	Molasses	2 gallons
	Glue (summer)	8 pounds
	Glue (winter)	7 pounds
	Glycerine	1 pint

Boil the molasses first by itself for about three-quarters of an hour, with constant skimming. Then add the hot glue, and boil another quarter of an hour. Then add the glycerine and boil for 5 to 10 minutes longer. This rule of boiling should be observed in all such compositions.

7. Soak glue in as much water as it will absorb. Then liquefy by heat and add a weight of glycerine about equal to that of the dry glue.

8.	Best glue	168 pounds
	Black molasses or honey	40 gallons
	India rubber dissolved in turpentine	16 pounds
	Venice turpentine	2 pounds
	Glycerine	12 pounds
	Vinegar	4 pounds
9.	Glue	10 pounds
	Sugar	10 pounds
	Glycerine	12 pounds

The composition is always cast in metal molds greased inside to prevent adhesion. The best glue should always be used, as a great deal depends upon its quality. A finished roller is tested, after the composition has been applied to the core, by drawing the fingers lightly over it. It should cling to them a little, and an experienced person can judge by the degree of adhesion sufficiently well for all practical purposes. This rule, however, does not apply in the case of a

patent composition, in which the property of chromic acid to make gelatine insoluble in water when the two are exposed together to daylight is utilized. This composition is made by adding bichromate to the usual ingredients. The finished roller is varnished with an oil varnish. It is said that such rollers can be inked more quickly than ordinary ones, and can be run at higher speeds. Another patent roller is the felt roller. In this felt is wrapped over a backing of woolen cloth on a wooden or metal core, being separated from the backing by means of some impervious fabric such as oilcloth. The felt itself is soaked with a mixture of tallow and ordinary copal varnish.—Oils, Colours and Drysalteries.

THE GALLO-ROMAN GRAVEYARD NEAR BEIMBACH.

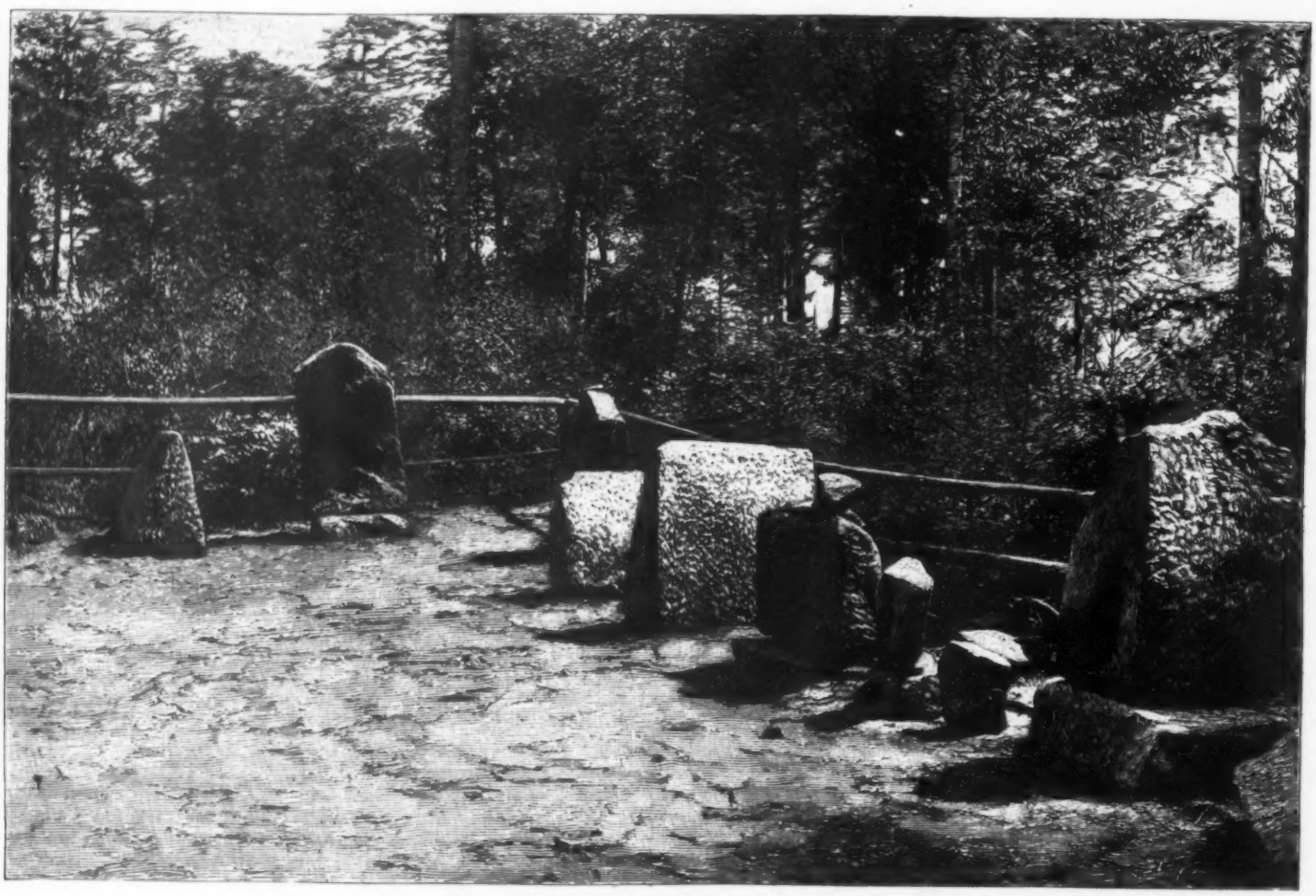
AFTER the meeting of the German Anthropological Society held this year, the members made an excursion from Metz to Alberschweiler, in Lorraine, to see relics of former civilizations, and specially the Gallo-Roman graveyard, Dreiheiligen, which lies above Beimbach on one of the mountains of the Wasgau Forest, about 1,739 feet above the level of the sea. There a number of gravestones have been brought together in an inclosed space, and just before this expedition the Lorraine Historical Society had begun to make excavations. Dreiheiligen is the best known of those cemeteries which are scattered over the mountains of the Wasgau Forest, and which prove that from 1,700 to 2,000 years ago there were villages where there is now a wide-spreading forest.

Most of the stones have been carried away to needles, buckles, knives, weapons, and vessels made by the Romans from fine terra sigillata or common clay in imitation of the native pottery, and, lastly, an object resembling a clay tobacco pipe with representations of animals on it. Some of these things are evidently of Roman origin, such as the coins, and others of native origin, such as the weapons which natives placed in the graves of their relatives.

The influence of the Romans is as unmistakable in the form of the gravestones as in the articles found in the graves, for besides the house blocks mentioned we also find in the graveyards of the Wasgau Forest stones which have at the top the tympan of the Roman gravestones, while their broad bases betray the fact that they have been made from house blocks, and among these partially Romanized stones are some which are totally without ornament, where the opening above-mentioned is lacking, and others on which there is pictorial decoration, a group of three busts—portraits of those whose ashes were placed in the urns—seeming to be a favorite ornament. At Dreiheiligen there are a number of stones with three busts, some being mutilated and some in perfect condition, which fact seems to give us a suggestion as to the origin of the name; for portraits of the ancients have many times been mistaken for representations of gods. For the above and our engraving we are indebted to the Illustrirte Zeitung.

THE MINERAL SPRINGS OF AUSTRIA.

THE mineral springs of Austria represent medicinal waters of the most varied chemical combinations, and adapted to the alleviation and cure of many diseases, for obesity, scrofulous affections, gout, anæmia, Bright's disease, chronic catarrh of the stomach or throat, and habitual constipation; warm, for severe cases of stomach catarrh and ulcers, chronic catarrh of the bowels, obstinate cases of jaundice, gall-stones, diabetes, and catarrh of the larynx and bronchia. The special attribute of the Radein springs is the considerable quantity of bound carbonic acid which they contain. The waters of the springs exercise a healing effect in cases of bladder and kidney diseases, and act favorably on catarrh of the respiratory organs. Gleichenberg contains four celebrated springs—the Constantin, Emma, Johannis, and Klausen steel springs. It is a spa much resorted to by sufferers from throat and lung diseases. For local treatment of catarrh, inhalation of an atomized product of the Constantin Spring—"spring brine"—is employed. By evaporation of the spring waters in large pans, steam being the motive power, the earth carbonates are expelled, and the remaining solution of alkalis reduced to one-half. When the aërometer shows a specific gravity of 1.01 the concentration process is stopped, and the one per cent solution filled into cylindrical containers. Through these by an automatic manipulation, the carbonic acid gas of the spring is conducted at night in order to effect the restoration of the carbonates to bicarbonates, a necessary process, for the reason that the carbonates generated by the heating of the alkalis might produce irritation of the mucous membrane of the bronchia. The Klausen steel waters are successfully employed as a remedy for poorness of blood and as a tonic for convalescents. The springs of Levico, in the Tyrol, have been known for more than two hundred years. The waters, owing to a combination of arsenious acid with sulphate of iron salt, possess a special virtue as a remedy in cases of anæmia, scrofula, nervous disorders and skin diseases. The Levico waters are crystalline, colorless and pure, and of proved efficacy in nervous affections and skin diseases. The Roncegno springs, also in the Tyrol, are noted for their arsenic properties, and the waters are efficacious in diseases of the blood, nerves, abdominal organs, and skin. These waters are also applied externally, mixed with one-third part distilled water, and used as a gargle or lotion; further, as a partial bath in cases of skin troubles. Upper Austria possesses two spas of great celebrity—Gastein and Hall. The Gastein thermal water takes its origin from sixteen springs. The temperature of these springs varies from 22 deg. to 49.5 deg. Reaumur, and remains the same throughout the year, the waters all showing the same chemical elements. The Gastein waters are helpful in diseases of the bladder and the kidneys, nervous dyspepsia, and chronic catarrh of the respiratory organs. Hall is specially famous for the iodine products of its springs, which are successfully employed in the form of poultices and baths, as also in internal doses for ailments of the bones and joints, for scrofula and anæmia. The province of Carinthia contains the two famous Preblau and "Römer" springs. The Preblau waters are known as the prototype of the purest of alkaline and carbonate of soda springs, and issue at a depth of five feet from the crystalline rock. They are largely used as table waters. Their export has steadily increased from about 100,000 bottles in 1871 to 500,000 bottles at the present time. The Carinthian "Römer" (Roman) Spring derives its name from its situation on the old Roman highway which connected Celeja with Vir-



THE GALLO-ROMAN GRAVEYARD NEAR BEIMBACH.

museums, but those which remain at Dreiheiligen, taken in connection with the results of the excavations, bring before us a mixture of Gallic and Roman customs. The blocks of stone with their straight sides sloped off to form a ridge at the top are evidently of native origin. Each one represents a house with a semicircular opening or a simple slit in the base line of the front to designate the door. These house blocks were generally without any ornament except where a frame for this door was indicated, and often enough even that is lacking; but a few of them are provided with inscriptions in imitation of the Roman custom, which shows that the native form of gravestones was retained even after the land came under Roman rule, and, furthermore, the names were generally written in Gallic, seldom in Latin. The undersides of these house blocks were generally hollowed out, and each one stood on a slab with a hole in the center, below which the receptacle containing the ashes of the dead was placed. In this way admission to the dead was obtained and the introduction of food, etc., made possible. These receptacles for the ashes were of stone or clay, more rarely of glass protected, generally, by stone cases. The custom of burning the bodies of their dead was common to the Romans of the time of Cæsar and the Gauls of the same time, and for three hundred years after that period it was followed in the burying grounds of the Wasgau Forest. These receptacles or urns received, besides the ashes of the dead man or woman, those of domestic animals, which, according to a time-honored custom, were burned with the bodies of their owners. Beside the urns were often placed articles of various kinds, including coins, jewelry,

The proceeds of the very large sale and exportation of the waters, however, represent only a part of the profit that the country derives from these springs. Situated in beautiful mountainous regions, they have become the nucleus of flourishing health resorts, to which thousands of visitors come annually. It is customary to collect from visitors staying for a longer period than five days a cure tax, graded according to rank and means of the visitor into first, second, and third class, and varying from 4 to 20 crowns (about 3s. 4d. to 16s. 8d.). The revenue thus derived is applied to beautifying the Spa, and providing several concerts daily. The province of Styria contains three spas of great importance—Rohitsch-Sauerbrunn, Radein, and Gleichenberg. The two celebrated springs of Rohitsch-Sauerbrunn—the Temple and Styria springs—are employed exclusively for drinking. The waters are saline, alkaline, acidulous, form a refreshing drink, and those of the Temple spring have been exported in large quantities to all parts of the world for two centuries. According to the United States Consul-General at Vienna, the export of the Styria Spring waters was begun only in 1884. They are especially favorable for diseases of the digestive organs. More than 1,000,000 quarts of these waters are annually exported. Up to 1889 the bottling was effected by means of pumping engines, but as by this method a part of the carbonic acid escaped, a new central filling plant was projected, a feeding shaft through which the waters should be conducted in enameled pipes at a moderate decline from the bottom of the spring inclosures. This has proved entirely successful, the escape of carbonic acid being avoided, enabling besides a more rapid and ample use of the springs. The waters are taken cold,

unum, the capital of the ancient Noricum. It issues from conglomerate rock at a rate of 14 quarts per minute, increased to 47 quarts by a force pumping engine. It is a permanently flowing spring, independent of all changes of the weather. The waters are clear, odorless, and of pleasant acidulous taste. The temperature is 10 deg. Celsius; the specific gravity, 1.003021. The proportions of iron and organic substances contained are remarkably small. The waters are efficacious for all affections of the mucous membrane, catarrh, coughs, hoarseness, throat troubles, digestive disturbances, and diseases of the bladder. The Darkan iodide-bromine spring is situated in the province of Silesia. Of all known iodine waters these contain the largest amount of fixed bromine elements. The iodide salts gained from this spring are used as admixtures to baths, washes for local application, and for wet compresses. Rickets, scrofula, skin affections, gout, rheumatism, and kindred diseases are said to be curable through use of this spring. The Guber springs, of Srebenica, in Bosnia, are noted particularly for the large amount of sulphate of protoxide of iron and arsenic oxide which the waters contain. They are most beneficial in diseases consequent on an abnormal composition of the blood, in skin and nervous disorders. The Sczcawnica springs, of Galicia, are alkaline, muriatic, acidulous, containing a large amount of iodine and bromine, and are beneficial in diseases of the respiratory organs and abdominal troubles. The province of Moravia contains two mineral springs of importance, those of Luhatowitz and Saratica. The former are alkaline-muriatic, and in the amount of carbonate, iodide, bromide and chloride of soda, as well as of iron which they contain, are to be reckoned among the most powerful and dissolvent of medicinal waters. They are particularly efficacious in lingering cases of catarrh, gouty affections, gravel, and stone. The Saratica waters are a mild but highly effective aperient, and are taken for catarrh of the stomach and bowels, gout, and obesity. It is probable that no other territory of equal extent in the world contains so many mineral springs and of so diversified a character in the healing uses to which their waters are applied as the northern half of Bohemia. Within this territory are Carlsbad, Marienbad, Bilin, Johannisbad, Frazensbad, and a multitude of other places less widely known, where mineral springs yield waters which cure disease by internal or external use. Near the city of Prague are several resorts, local in reputation, but situated among delightful surroundings. Bad Schlag is small, but its baths are found to be health-giving. Liebwerda is more populous during the season, and many people in impaired health find relief from its chalybeate springs. Johannisbad in the Riesengeberge has a large number of springs. The temperature of the water is always 82 deg. F. It is chiefly used for baths, and is remedial in all nervous disorders.—Journal of the Society of Arts.

THE VENOM OF SERPENTS, AND ANTIVENOMOUS SERUM.

THE bacteriological researches made during recent years have shown that a great resemblance exists between microbian or toxine poisons and the poison secreted by the salivary glands of venomous serpents. They have shown also that serotherapy (that is to say, treatment by the serum of the blood of vaccinated animals), which has given so brilliant results in the treatment of diphtheria and the plague, is applicable to the therapeutics of venomous bites with still greater precision.

Venomous serpents are particularly abundant in some of the countries of the tropical zone. India and Australia dispute with each other the sorry privilege of harboring the most formidable species. According to the official statistics of the English government, more than 22,000 persons anually succumb, in India alone, to the bite of the naja, cobra and bungara. In Martinique, the *Bothrops* or fer-de-lance, in Algeria the horned viper, and in Senegal and the Soudan the black naja or spitting snake claim a still greater number of victims, especially among the aboriginal population. The toxic principle of all the poisons is the same, whatever be the species of serpent that secretes it. There is no difference in the origin, but only in the degree of toxicity. Thus, it has been found that while it takes, on an average, 4 milligrammes of the venom of the French viper to kill a rabbit, it requires but half a milligramme of the poison of the cobra of India to produce the same effect in the same time.

The bite of a snake produces in most cases a very intense pain followed by numbness and cramps rapidly extending toward the extremity of the limb affected and throughout nearly the whole body. Then, in a few instants, fainting and syncope supervene. When the quantity of venom inoculated is great enough to cause death, the respiration soon becomes anxious and laborious. The mouth contracts and becomes slabbery, the tongue swells and the jaws close tightly, and then the unfortunate sufferer falls into a very deep coma and expires in a few hours.

A physiological study as complete as possible of envenomation and antivenomous serotherapy that I have been pursuing for the last ten years, first at the Pasteur Institute of Saigon, then at Paris, and finally at the Pasteur Institute of Lille, says Dr. Calmette, in La Nature, made it necessary for me to procure very large quantities of venoms of all kinds.

In order to preserve venomous serpents in a living state, I was obliged to have constructed a hot-house specially arranged for this purpose. Therein the reptiles live for several months, provided they are fed by force, since they almost always refuse to take food spontaneously in captivity.

The poison is collected about every two weeks in the following manner: I fix the serpent's head by a long forceps with flat branches, and afterward grasp the animal by the neck with the left hand in such a way as to deprive it of any point of support whatever. The head is then disengaged and left at liberty, and an assistant introduces between the jaws a large watch glass. I then compress the poison glands on each side of the upper maxillary; whereupon the venom flows through the fangs into the watch glass.

The product obtained is immediately dried in a vacuum in order to assure its preservation. The venom resembles powdered resin.

The serpent is afterward fed by introducing a glass funnel into its œsophagus, and breaking therein two or three raw eggs, the contents of which flow directly into the stomach; after which the reptile is put back into its cage.

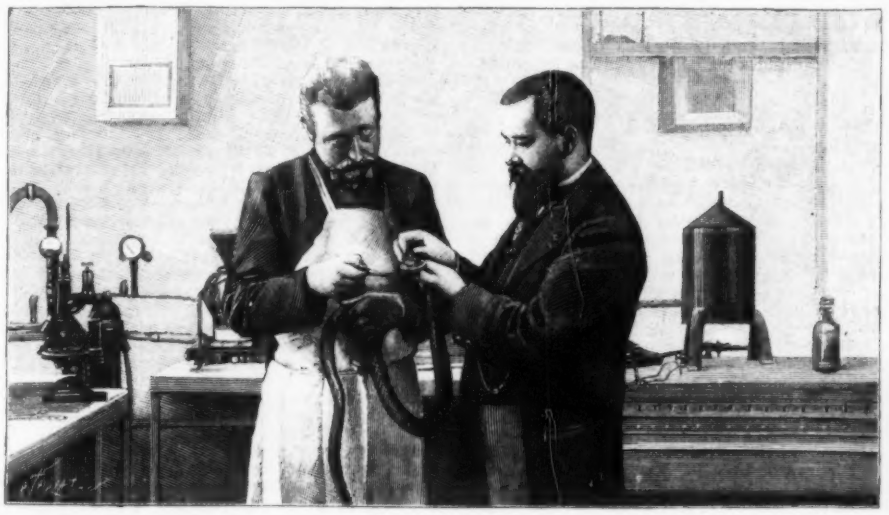


FIG. 1.—COLLECTING POISON FROM THE GLANDS OF THE COBRA DI CAPELLO.

For experimentation, the dried poison is dissolved in a 3½ per cent solution of salt water. I then prepare an exactly proportioned solution (1 per cent, for example) that will permit of determining the toxic dose per kilogramme of living animal. Ordinarily, with the venom of the cobra, a dose of the solution corresponding to 0.5 of a milligramme will kill a two-kilogramme rabbit in two or three hours by subcutaneous inoculation.

Such dose, surely mortal, being fixed, it is possible to make use of a solution of the same proportions for vaccinating other animals, such as dogs and horses. Into these animals are injected, at first for several days in succession, very minute quantities of poison incapable of producing grave accidents, and then the quantity injected each time is gradually increased with great precaution. At the end of a certain length of time, say about sixteen months with horses, the latter may be made to support, without causing sickness, doses of poison two hundred times more deadly, that is to say, doses capable of killing two hundred non-vaccinated horses.

Such horses are then ready to furnish a serum preventive and curative of envenomation. They may be bled every two or three weeks, and at every bleeding there may be obtained from 6 to 8 liters of blood, which will furnish 2 or 3 liters of active serum.

In order that the antitoxic activity of the serum shall remain constant, it is necessary, after each bleeding, to reinforce the immunity of the horses by a new injection of diluted venom. The serum, which is first tried upon rabbits, should protect the latter at in dose of at least one cubic centimeter against a quantity of venom capable of killing rabbits of the same weight in twenty minutes by intravenous injection. It is afterward put into small bottles of 10 cubic centimeters capacity, each representing one therapeutical dose ready for use.

The Pasteur Institute of Lille and the Pasteur Institute of Paris are now sending antivenomous serum to all countries in which poisonous serpents exist, and principally to Australia, India and South America. It has been employed in a great number of cases since 1896, and always with success. It produces so rapid curative effects as to cause surprise at the intensity of its action.

Owing to it, the treatment of snake bite has become one of the simplest of matters. Such treatment consists in the injection of 10 or 20 cubic centimeters of serum under the skin of the abdomen of the person bitten. The injecting is done with a hypodermic syringe of large size like that employed in the treatment of diphtheria. It is not profitable to inject the serum at the level of the bite, since it is absorbed

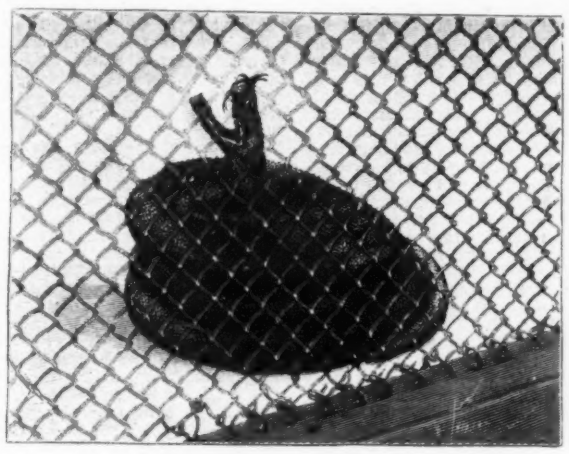


FIG. 3.—HORNED VIPER OF ALGERIA.

FIG. 2.—FEEDING A COBRA.

more rapidly when it is injected into the loose tissues of the abdominal skin. The intervention is always efficacious so long as the patient is not as yet in a state of asphyxia; and it is well to know that it almost always takes four to five hours for the latter to manifest itself.

Antivenomous serotherapy therefore presents no difficulty in the way of practical application, and is now within the reach not only of physicians, but even of travelers, hunters and all persons whose business exposes them to the danger of being bitten by poisonous snakes.

RECENT SCIENCE.[1]

I.

THE exploration of the higher layers of the atmosphere by the aid of high-level observatories, kites, and balloons continues to engross the attention of meteorologists. This is not a mere fashion—science also has its fashions—but an urgent need. To gain knowledge of what is going on in the air, miles above the earth's surface, has become a matter of first necessity. Those who issue the weather forecasts see that they can make no further progress so long as they do not extend their observations higher up in the air envelope of our globe; and those who work upon the theory of the general circulation of the atmosphere come to the same conclusion. Our instruments carefully record the displacements of cold and warm air close to the earth's surface; but it is only at much greater heights that we find the mighty air-currents blowing undisturbed round the earth, and discover the origin of the great "heat waves" and waves of cold weather. Thereto we must go to study them. Glaisher had fully understood this necessity when he undertook his venturesome balloon ascents; but while interest in such explorations died away in Britain, it was born with a new vigor in the United States, in France, in Germany, in Austria, in Russia, and the work is now carried on with a remarkable zeal.

The idea was, first, to build meteorological observatories on the tops of high isolated peaks. The Sonnblick observatory, which won a world-reputation for its work, the Ben Nevis in Scotland, Jansen's Mont Blanc observatory, Abbas-tuman in the Caucasus, Arequipa in Peru, and so on, were the fruits of that effort—the highest observatory in the world having been planted by the Americans in Peru, on the El Misti peak, at an altitude of 19,200 feet.

These institutions have already rendered good service to science. However, they necessarily remain but few in number; they do not reach the uppermost levels of the atmosphere, and moreover the air-currents which are observed on more or less isolated peaks still remain complicated by the proximity of the plains and the mountains. Consequently, the United States meteorologists, keeping in view their practical aim—the prediction of weather—came to the conclusion that a survey of the temperatures, pressures, and air-currents which prevail at a height of, let us say, one mile above the surface of the soil, ought to be made regularly every day over the whole of the American continent. Seventeen spots were selected for that purpose, and the idea of Willis Moore—the promoter of this scheme—was that every morning kites provided with self-registering instruments would be flown at each of these spots, so as to bring down regular reports of temperature, pressure, and so on from the one-mile level above the soil.[2]

The problem was evidently by no means an easy one. A small kite would not lift the instrument-box when the wind was not strong enough, while a big kite was liable to break off its moorings when it met a stronger wind at a higher level, and thus to be lost for ever. Finally, the American meteorologists settled upon the Hargrave type of kite, which has the shape of a quadrangular box of which the lid and the bottom have been removed, or rather of a tandem composed of two such boxes. Thousands of such kites of miniature dimensions are now flown by old and young at all watering-places. The meteorological kite is of course much bigger than the toy. It has eighty to ninety square feet of lifting surface (slightly concave), and it is held by a steel piano wire. A spring bridle, a machine for winding up miles of wire when the kite is brought down, and a meteorograph—that is, an instrument weighing a trifle over two pounds, but containing self-registering instruments for taking note of temperature, pressure, miosture, and force of wind—complete the equipment. The length of the wire which is paid out and the angle of its inclination give the exact height reached by the kite.

The kite became in this way a powerful aid to meteorology. Gradually perfected, it extended its excursions higher and higher in the air, and while the first kites hardly reached an altitude of 2,070 feet, they now rise beyond 12,000 feet, and thus penetrate into regions of which the normal temperature is near the Fahrenheit zero. Altogether, the kite offers many advantages. The height it has reached being measured directly, a control of barometric measurements is obtained. Its ascension can be slackened at will so as to be sure that the instruments have taken the temperature of their surroundings, and it may be kept any length of time at a given height so as to represent a real floating observatory. But it has also its disadvantages. Thus the scheme of Willis Moore could only partially be realized, as there are many days (54 per cent on the average) when the kites cannot be flown either for lack of wind or on account of too much wind. With all that, the kites were doing good work, when the Cuban War, which put the meteorological service to a hard, practical test, and the subsequent necessity of extending the meteorological net over the West Indies, put an end to the regular kite-explorations.

Most valuable data, especially as regards the laws of decrease of temperature in the higher strata of air, were obtained during the 1,217 kite ascensions which had been made in the meantime.[3] It was also found that the kite observations would often warn the meteorologist about the coming changes of weather; a "hot wave" was actually caught while it was coming. As to the clouds, their coming down at nights and their floating higher up in daytime were registered with perfect accuracy by the instruments attached to the kites. Most interesting observations relative to the circulation of air in areas of low and high pressure were also made in this way.[4]

While the United States made thus a specialty of kites, France took chiefly to unmanned balloons, or *ballons sondes*. The very first experiments proved to be most encouraging, when an unmanned balloon launched from Paris by Hermite rose to a height of 45,000 feet, its self-recording instruments working perfectly to an altitude of 36,000 feet; while Assmann's unmanned balloon, launched from Berlin, crossed over in ten hours to the Servian frontier, and brought full records of its journey. It rose to about 46,500 feet, where the barometric pressure was only 3.3 inches—thus showing that eight-ninths of the whole atmospheric air lay below the balloon. In both cases the temperature at the 36,000-foot level was found to be much lower than it was expected; namely, as low as 60 deg. below the Fahrenheit zero (—51 deg. and —52 deg. Celsius respectively). Eight balloons out of ten came down to the earth in perfect order. Consequently, beginning in the spring of 1898, Teisserenc de Bort, at Trappes, near Paris, has regularly launched his *ballons sondes*, several each month, so that he could report in 1900, and tabulate the results of no fewer than 240 ascensions. A sort of nearly permanent floating observatory was thus established. One-half of the balloons reached the 27,000-foot level, one-quarter rose to 39,000 feet, and several went beyond the altitude of 42,000 feet (eight miles). Very few were lost. An inscription in different languages, asking those who find the balloon to take care of it and to warn the nearest observatory, promising a reward of a few pounds for that trouble, is quite sufficient—even in Russia—to secure the safety of the messenger which descends from the skies. An excess of zeal is all that is to be feared—the good people who took care of one of the early balloons of Violle, going even through the trouble of well polishing a smoked cylinder upon which the records of the meteorograph were scratched by a needle, thus wiping off both "the dirt" and the records.[5]

At the same time the system of exploration of the atmosphere by means of manned balloons was worked out, especially in Germany, and partly also in Russia, where one of the members of the military balloon staff, Pomortseff, published in 1891 the results of his forty ascensions, and fully confirmed Hann's conclusions as regards the distribution of temperature in areas of low and high pressure. However, isolated observations, even when they are numerous, are not sufficient, and at the international aeronautic conferences of 1896 and 1898 it was agreed between Austrian, Bavarian, Belgian, French, German, and Russian aeronauts that international ascents at the beginning of each month would be organized. Manned and unmanned balloons, as also captive balloon-kites, consequently start in considerable numbers on given days from Paris, Brussels, Strasburg, Munich, Berlin, Vienna, and St. Petersburg—all provided with identical or similar instruments, approved by the conferences. In this international exploration Germany stands foremost with her manned balloons, the difficulty of breathing in the extremely rarefied air of the great altitudes having been overcome by taking a supply of oxygen. In this way Dr. Berson could reach at Berlin an altitude of 9,155 meters (30,030 feet), and so long as his supply of oxygen lasted he experienced none of the symptoms of "mountain disease." No man had been before at such a height, but even this record was beaten on the 1st of August last by Berson and Süring, who reached the altitude of 10,300 meters (33,700 feet), finding there a temperature of —40 deg. Fahrenheit. As to the unmanned balloons, they have explored, of course, still greater heights; the capricious Berlin *ballon sonde* "Cirrhus" rose as high as 53,500 and 60,600 feet, while one of Teisserenc de Bort's unmanned balloons went to a height of 22 kilometers, i. e., about 13½ miles.

The results obtained from all these explorations of the last twelve years are already full of importance. Everyone knows that the temperature of the air decreases as we rise higher and higher in the atmosphere, and that the summits of our high mountains lie amid layers of air so cool that the snow does not disappear from them. There may be occasionally a local inversion of temperatures—that is, in certain localities, under certain conditions, especially under a cloudy sky, the temperature may increase up to a certain height; but as a rule it decreases as we rise above the soil at a rate of from three to five Fahrenheit degrees for each thousand feet. Consequently, even in summer we find in middle Europe the temperature of freezing at a height of from 6,600 to 10,000 feet, and a still greater cold prevails at still greater heights.

However, it was never expected by meteorologists that the upper layers of the atmosphere would be so cold as they are in reality. It appears now that all the observations of Glaisher, upon which our knowledge of the upper layers was chiefly based, gave too high temperatures. Not only because a thermometer, unless it is very sensitive and the air round it well ventilated, takes some time before it shows the real temperature of the layer of air which the balloon is piercing, but especially because of the solar radiation, which, in the high layers of a rarefied atmosphere and in the full sunshine which reigns above the clouds, is very strong, and overheats the instruments. This was one of the first difficulties which the meteorologists had to overcome before such perfected instruments as Assmann's psychrometer and the instruments of Violle and Teisserenc de Bort were introduced. Thus it appears now that the average temperature at an altitude of 20,000 feet is 13 deg. *below* the Fahrenheit zero (as against Glaisher's 3 deg. to 32 deg. Fahrenheit), and that at the altitude of 25,000 feet the air is full 35 deg. below the Fahrenheit zero, instead of the —4 deg. to +16 deg. Fahrenheit which Glaisher gave for that altitude.[6] Such low temperatures prevail, it must be remarked, all the year around.[7]

Another important fact was revealed by these explorations. It was generally believed that the decrease of temperature becomes slower and slower in the higher portions of the atmosphere. It appears, however, that at great altitudes it is the reverse which prevails. The ratio of decrease, which is about three Fahrenheit degrees for each 1,000 feet in the lower strata, grows higher and higher, reaching nearly twice as much at the highest levels. This upsets many a current theory.

It would be impossible to analyze here the extremely interesting deductions which Cleveland Abbé makes from the explorations of Teisserenc de Bort, or those which Bezold draws from the German balloon explorations; still less would it be possible to mention the mass of information contained in the luxuriously edited *Wissenschaftliche Luftfahrten*.[8] Two points, however, deserve a special mention. One is the quite unexpected discovery that the difference between summer and winter is felt even at such great altitudes as 30,000 feet. Of course, the seasons are not so well pronounced there as they are with us; but even at this great height they are fully noticeable—the average temperature of the 30,000-foot layer in March being about 65 deg. below the Fahrenheit zero, while that of August (the warmest month) is only —44 deg.[9] Higher up, the layers of extremely thin rarefied air are even much cooler than that, and rapidly merge into the frozen depths of the interplanetary space.

Another extremely interesting fact is this. Everyone knows the spell of cold weather which we experience in Europe and Northern Asia about the middle or in the first half of May—the so-called *Saints de glace* of the French peasants. This "cold wave" has long since been a puzzle for meteorologists. It is so widely spread that some cosmic cause—not telluric—was suspected; but then, the retardation with which the cold reaches Siberia, whereto it comes about the 20th or 22d of May, was an argument against the cosmic origin of the cold wave. If it were due to the earth entering an especially cold portion of the solar system, no such retardation would take place. Consequently, an international balloon ascent was organized on the 13th of May, 1897, balloons starting on that day from Strasburg, Berlin, and St. Petersburg. These ascents proved that the cold wave surely is not due to some small local disturbance, such as icebergs and the like. It is caused by a mass of air, 30,000 feet thick and covering all Europe, which is brought into a rotatory motion, so that cold air from the north is brought down upon Western Europe, while warm air is poured upon Eastern Europe from the southwest. What is the cause of that regularly recurring rotation of the atmosphere we do not know yet, but the amount of energy it represents is immense, and its cause must be consequently more general than mere local disturbances.

Altogether when one rises in a balloon far above the petty asperities of the earth's surface, one finds also a much simpler distribution of temperatures, pressures, and air-currents; and it will be through such data as those which were collected during an international ascent on the 3d of October, 1899, that knowledge will be won about the cyclonic and anticylonic disturbances to which our weather is due.

(To be continued.)

THE ACTION OF CHROMATES AND BICHROMATES ON COLLOIDS (GELATINE, ALBUMEN, GUM, ETC.).

By PROF. R. NAMIAS.

THE power of rendering colloid bodies insoluble after exposure to light which is possessed by alkaline chromates and bichromates is due, it is certain, both to the partial reduction of the chromate or bichromate to a salt of chromium (chromium chromate), which combines with the colloid, giving as a result insoluble compounds; and also to the oxidization of the colloids, which are thereby transformed into other compounds less soluble. That this oxidizing action is an important factor may be gathered from the case of gum arabic. Gum arabic is only rendered incompletely insoluble by chromium chromate, although in the presence of a bichromate and after exposure to light it is rendered almost entirely insoluble.

The chromium salt which is formed upon exposure to light, and helps to render the colloid insoluble, is certainly not chromium oxide—for one reason, because of its insolubility, which would prevent it from acting. The action must be attributed to more or less basic chromium chromate which forms. Neutral chromium chromate has a composition which corresponds to the

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[1] P. Kropotkin, in The Nineteenth Century. Reprinted by permission of the Leonard Scott Publication Company, New York.

[2] See the very interesting paper by Willis Moore in Weather Bureau Publications, No. 138 (1897) and No. 191 (1899), reprint from Forum, and in a succession of issues of the Monthly Weather Review, Washington, 1897-1901, vols. xxv. to xxix.

[3] H. C. Frankenfield, in Monthly Weather Review; also in Nature, Nov. 29, 1900, lxiii. 109.

[4] Especially on September 21-24, 1898. See Helm Clayton's Studies of Cyclonic and Anticyclonic Phenomena with Kites, in Blue Hill Observatory Bulletin, 1899.

[5] See Teisserenc de Bort's reports in Comptes Rendus, 1899, vol. cxxix. pp. 131 and 417, and 1900, vol. cxxxi. p. 920. Analyzed and discussed by Cleveland Abbe in Monthly Weather Review, September, 1899, p. 415 (tables); by W. Trabert before the Natural Sciences' Verein at Vienna, and in Jahrbuch der Naturwissenschaften, xv. 246; and in Nature.

[6] In order to be sure that the distribution of temperatures over the British Isles is not very much different from what it is over North Germany and North France, Berson and Süring made two simultaneous ascensions—the one, in his own balloon, from London, and the other from Berlin. At the altitude of 20,000 feet both found almost identical temperatures, which were the usual ones for that time of the year. Direct experiments were also made upon a thermometer placed in the way Glaisher used to place his instrument: it gave much too high readings. As it is known, however, that the gradient of temperature-decrease is different on the Atlantic border of the United States and in the interior of the continent, it is most desirable that Britain should at last join the Continental nations in their exploration of the atmosphere.

[7] Here is a table which will give an idea of the distribution of temperatures (in Fahrenheit degrees) in the atmosphere Trabert obtained it by comparing the German results with those of Teisserenc de Bort:

Height in feet:	The soil	6,600	16,500	23,000	26,000	32,800
North Germany:	50°	32°	1°	—20°	—36°	.....
North France:	48°	32°	3°	—20°	—36°	—60°

[8] Edited by R. Assmann and A. Berson. Bezold's introductory review, very suggestive, has appeared as a separate pamphlet.

[9] Teisserenc de Bort, in Comptes Rendus, 1900, vol. cxxxi.

formula $Cr_2O_3, 3CrO_3$. Of basic chromates there are quite a number. One which seems to be well defined is Cr_2O_3, CrO_3, which is sometimes written with the simplified formula, CrO_2.

In actual practice, potassium or ammonium bichromate is used indifferently. Sometimes the formulæ given provide for the addition of ammonia, and sometimes they do not. This would hardly seem to be a satisfactory state of things, and I took advantage therefore of an opportunity recently to go into the question, both from the theoretical and from the practical point of view.

It is impossible to help noticing that, while the relative quantities of the two salts of potassium and ammonium bichromate, which are chemically correspondent, are 116 of the first to 100 of the second, if one employs the two bichromates in these proportions it is found at once that the ammonium bichromate has a quicker and more powerful action.

This is easily explained when it is borne in mind that in the case of ammonium bichromate all the chromium present is effective, while in the case of potassium bichromate only that is active which is in the condition of chromic anhydride. Now, I would remind my readers that the bichromates can be considered as a combination of neutral chromate with chromic anhydride. Thus, one can write the formulæ of the two bichromates in the following:

K_2CrO_4, CrO_3.	$(NH_4)_2CrO_4, CrO_3$.
Potassium bichromate.	Ammonium bichromate.

Now, the neutral potassium chromate in the presence of a colloid is almost unaffected by light, for the tendency to decompose into potassium oxide and chromic anhydride is at a minimum. This is because the potassium oxide which forms—which remains present—tends to prevent by its presence the continuation of the decomposition of the chromate itself. In the case of neutral ammonium chromate, on the contrary, the alkali, being volatile, easily and quickly disappears, and so the process of decomposition goes on right up to the end.

This is shown in the following equation, the chromic anhydride which is set at liberty acting by oxidizing organic matter which is present:

$(NH_4)_2CrO_4$ Neutral ammonium chromate.	=	$H_2O + 2NH_3$ = water + ammonia	$+ CrO_3$. + chromic anhydride.

This may be put in other words by saying that in the case of the decomposition of a body by light, the sensitiveness of the compound is governed not merely by the quality inherent in the compound itself, but also by the greater or less facilities which are afforded for the getting rid of one of the products of the decomposition. It follows that ammonium bichromate can undergo reduction to a much greater extent than potassium bichromate, and it is therefore necessary to employ a much greater quantity of the latter to obtain the same effect in an equal or even in a longer time.

The addition of ammonia to the bichromate solution is useful in certain cases, but not in all. It has the effect of changing the bichromate to the neutral chromate. When added to a solution of potassium bichromate, the addition of ammonia acts by transforming it into a mixture of the two neutral chromates of potassium and of ammonium, of which the latter alone, as I have already said, is effective. With ammonium bichromate, the addition of ammonia gives only neutral ammonium chromate, which is very active. Neutral ammonium chromate acts in a less active manner than the bichromates. It will therefore generally be found convenient, when it is proposed to neutralize the bichromate, to employ ammonium and not potassium bichromate, in order not to diminish the action too much.

The addition of ammonia to a bichromate solution ought to be made in such a manner as to change the orange yellow color of the liquid to a citron yellow, and it is a good thing to make it until the mixture smells of ammonia. The excess of ammonia has no injurious influence, for as the film dries the ammonia volatilizes.

But if it is proposed only to transform a part of the bichromate into neutral chromate, it is not advisable to follow the method so often recommended in formulæ, of adding a stated volume of liquor ammonia thereto. Ammonia solution is so variable in strength that such a method can only be adopted with the hope of obtaining uniform results by making an elaborate calculation, taking for its basis the actual weight of ammonia gas contained in the particular solution which is being used at the moment. It is a much more simple plan to divide the bichromate solution into two equal or unequal parts, as the case may be, into one of which sufficient ammonia solution is poured just to change the orange color completely to yellow without exceeding this point but very slightly, and then to mix the two solutions. In this way we can obtain bichromate solutions which, in contact with colloids in the presence of light, display an energy which is intermediary between that of the pure solutions of bichromate and that of neutral ammonium chromate.

It may be noted that the partial or total neutralization of bichromate with ammonia is particularly useful in the case of those colloid bodies which tend to become insoluble by the action of acids, as for example, with albumen.

In making up solutions or preparations of albumen with bichromate, it is always useful to add an excess of ammonia. Solutions are obtained in that way which keep well for several months, whereas without the addition of ammonia the solution keeps very badly or for a very short time, and even when employed at once it often produces in the dried film a partial insolubility before exposure. But in the enamel process, the addition of ammonia to the mixture of bichromate and fish glue is not beneficial, since it makes a film that is less resistant, and one which tends more easily to become detached from its support. Therefore, when a mixture of fish glue with a little albumen is employed, it is well not to add ammonia to neutralize the bichromate. By so doing, I have found that when the sensitive mixture is to be used after it has been made for two or three days, there need be no fear of the trouble that would be likely to occur if albumen by itself were being used.

The employment of neutralized bichromate, on the other hand, is an advantage in sensitizing carbon tissue, when it is to be kept for as long as possible, because the ammonium chromate acts in a slower manner, not only when exposed to light, but in the reaction which goes on in the tissue when it is kept from the light. Preparations of gum arabic also keep much longer if they are sensitized with a bichromate solution to which ammonia has been added.

Bichromates which have been transformed into chromates by the addition of ammonia have still another advantage, which renders them preferable in certain cases. They are much more soluble. For example, one can prepare solutions having a concentration of as much as 25 per cent, while with potassium bichromate according to the season, one can only obtain from 8 to 10 per cent solutions, and with ammonium bichromate 12 to 15 per cent. The great solubility of neutral chromates does away entirely with the fear of invisible crystallizations taking place in the film of gelatine, gum, or albumen, as can easily be shown with ammonium bichromate, and still more easily with potassium bichromate.

One colloid body which, so far as I know, has not yet been experimented with to any extent, is a mixture of chromate and casein. A solution of casein in ammonia or in borax may be made, and a solution of ammonium bichromate, neutralized with ammonia, added to it. In this way, a solution is obtained which, after filtering, may be spread upon paper or glass, and gives a film insoluble in water, but soluble in alkaline solutions. After exposure to light, the film becomes insoluble in alkaline solutions also.

Before leaving this subject, I would like to point out an experiment which I have made recently, which may help to show how complex is the action which the bichromates produce on colloid bodies in the presence of light. I took a 10 per cent solution of ammonium bichromate, added to it a little glucose, and heated it for a long time in a covered vessel. The yellow liquid became a very marked brown, on account of reduction of the glucose, brought about by the heat. One may take it that, under these conditions, a product is obtained resembling to some extent that which forms under the action of light upon bichromate in the presence of organic matter. On the other hand, it may be pointed out that the resulting solution only has a very slight action in rendering gelatine insoluble. I have further experiments in hand on the action of chromate and the salts of chromium in gelatine to which I may recur later on.—Photography.

THE HISTORY OF ALCOHOL.*

By DR. B. NEWMANN, Privatdocent, Darmstadt.

WHILE the history of several of the chemical-technical industries has been excellently written up—for example, the history of Sugar, by E. O. von Lippman; that of Explosives, by Romocki, etc.—as yet we possess no similar detailed story of the origin and development of quite a number of substances belonging to the same class of products, among them one of the most important of all—Alcohol. In all the existing special works on alcohol, chapters or sections devoted to the history of the substance, are conspicuous by their absence. Now, some seven or eight hundred years after the discovery of alcohol, a special literature has arisen with it as the topic, embracing works on the methods of its preparation, works on its uses; on the materials from which it is derived, etc., and it seems that it is worth while to take at least a short glance into its history.

From the writings of the ancients we learn that long before the beginning of our method of reckoning time, liquids containing alcohol were well known, and especially well known, in even the remotest ages, was wine-making from the juice of the grape. It is also well known that the Egyptians and the ancestors of the Germans prepared liquors similar to beer, and further, that the juices of the palm tree, of fruit, and of honey, etc., were made to undergo alcoholic fermentation, and yield intoxicating liquors. All of the peoples, however, who had learned and practised these methods, were ignorant of pure alcohol. They had no distilling apparatus, fit at least to drive off and preserve the involatile constituent of their wines or beers. In Pliny alone do we find a statement which has reference to the alcoholic content of wines—that wherein he says that the Falernian is distinguishable from all other wines by its inflammability.[1] Only after the discovery, by the Alexandrians, of improved distilling apparatus, do we find evidences that wine was submitted to distillation, and the inflammable material separated therefrom.

Marcus Græcus, who lived in the eighth century, in a work by him entitled "Liber ignium ad comburendos hostes" (The book of fires for the destruction of enemies), says:

"Ardent-water (Aquam ardentem) you can make in the following manner: Take black wine, thick and old, and in one quarta[2] of it, rub up 2 ounces of live sulphur, most finely powdered; 2 pounds of tartar derived from good, white wine, and 2 ounces of common salt. Place the ingredients in curcurbit[3], well leaded, put on the alembic, and distill off the burning or ardent-water, which should be preserved in a closed glass vessel[4]."

The term aqua vitæ as the name for alcohol came later into use, and is first found in the Latin translation of Gheber's writings (VIII. century). Here, for the first time, also (in the Testamentum), do we find alcohol recommended as an agent for the solution of various substances. Says he: "A salt is better extracted from calcined bodies by means of aqua vitæ, derived from white wine for white calcinations, while for red ones distilled vinegar is best." Neither in the "Testamentum" of Gheber, or in the "Liber Perfecti Magisterii" of Rhases (about 900 A. D.), however, is anything said of the inflammability of alcohol.

Rhases writes: The preparation of aqua vitæ is simple. Take of the occult any desired quantity, and stir strongly until it becomes like marrow, set it away to ferment, day and night, after which put it into a still and distill off. The surgeon, Albucassis of Zahara (who died in 1122 A. D.), by contemporary writers also called Abul Cassis, Alzaharavius, Buchalsis Ben Aferazeris, in his work, entitled "Servitor" (published in Latin first at Venice, in 1471), describes minutely a distilling apparatus made of glass and burnt clay. In the same work he describes the distillation of rose-water, and the subjection of wines to distillation. The alcoholic liquid thus obtained he called vinum ustum, burnt wine, using the words "burn" or "burnt," and "distill" or "distilled" as synonymous, just as they are used in Germany to-day. In this way we (the Germans) get our uncouth word "Branntwein."

The Arabian physicians of the beginning of the twelfth century, Merwan Ebn Zahar (Avenzoar), earlier the body-surgeon to the Sultan of Morocco; Ackmed Ebn Roshed (Averrhoës) and others, used spirit of wine as a stimulant in medicine. Cardinal Vitalis de Furno, of Basle, Switzerland, in a book published in the thirteenth century, and entitled "Selectiorum remediorum pro conservanda sanitate ad totius corporis humani morbos," extolled alcohol as the Universal Panacea. Thaddeus of Florence, who taught the art of medicine at Bologna, in the second half of the thirteenth century, did the same. At the beginning of the fourteenth century, the distillation of alcohol was still considered a very difficult and ceremonious operation. Indeed, distillation was even then regarded as a secret art, and in alcohol the alchemists discovered the foundation or beginning of their "vegetable philosophers' stone," as we learn in the writings of Raymundus Lullius (1235-1315), and Arnoldus of Villanova ("Villanovanus"), who flourished in the last half of the thirteenth and first quarter of the fourteenth, and who is frequently but incorrectly referred to by modern writers as the discoverer of the art of distilling alcohol. As we have seen, the Arabians anticipated him by several hundred years, and we can at most merely assume that he laid the foundation of his more exact and intimate acquaintance with the substance (alcohol) somewhere in Central Europe.

According to Alexander Tassoni, as early as the fifteenth century (by others relegated to a century earlier), great quantities of brandy were exported from Italy, over the Alps. The Modenese, on the occasion of an extraordinarily immense vintage, we are told, converted a part of the wine into brandy, and drove a lively trade in the "water of life" (aqua vitæ) with the Germans. The Viennese, jealous of the profits those of Modena were raking in, at once also entered into the distillation and export. It is scarcely probable that these great quantities of liquor should have been used in medicine only, but at just what period brandy became a popular drink in Germany, we cannot determine with any degree of accuracy. At any rate, that we were forestalled therein by the populations of the more southern wine-producing countries, and especially Italy, seems certain. It was in Italy, too, that the soldiers, drawn thither by the numerous wars, of which her soil was the amphitheater, first made the acquaintance of brandy, and learned to love the tipple. It may be, too, that in the outset, the liquor was taken as a prophylactic, merely, against the constantly returning epidemics of the plague (the Black Death), and thus the soldiers became addicted to its use. This much is certain, however, that at the end of the fifteenth century "brandy" was on tap (Branntwein schänkte), and was drunk in such quantities that laws became necessary for the control of its use. At the same time alcohol, in one shape or another, was being used more and more in medicine.

The author has in his possession two German prints dating from this period, one of which is devoted to "Geprannten Wasser" (distilled water, but meaning brandy), and the other to "Gepranntwein" (brandy), and both of which place before us in a remarkable manner the relations which brandy had to the existing times. Michael Schrick, doctor of medicine (Doctor der Ercznei) is the author of the first named publication—"Verzeichnuss der Ausgeprannten Wasser"—which appeared at Auburg in 1494. An earlier exemplar, which may be seen in Kloster Buxheim, of 1483, consisted of twelve leaves, without title, and began with the words: "Herein stands depicted distilled water (i. e., brandy), in what measure one must apply it to suffering, and make use of it. All of which Master Michael Schrick, doctor of medicine, hath described, and is good and useful to know[5]. After which follows a useful discussion of several distilled waters, how one shall use them and employ them to the bettering of the health of man. And this booklet has Meister Schrick, doctor of medicine, collated out of books, and writ through love and at the especial prayer of honorable persons[6]."

Following this were receipts for a number of aromatic waters—rose-water, white-lily-water, snow-drop-water, field-lily-water, etc. The latter part deals entirely with "Geprannt Wein," and the diseases and conditions in which it is recommended as a remedy. These latter are as follows:

"Brandy is good for the gout, rubbed on the same."

"Whoever is hoarse, let him rub brandy around his throat, and drink of the same, three mornings in succession, fasting."

"Anybody that will drink a half tablespoonful of brandy every morning, will never be sick."

"Item: When a man be dying, let one pour a little

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* In the Pharmaceutische Centralhalle.—Translated for the National Druggist.

[1] Nec ulli in vino major auctoritas solum vinorum flamma ascenditur.

[2] Quarta. The Translator is at a loss to know whether the author here means a fourth of an amphora (which would be 2¼ gallons), or the fourth of a congius (about a quart).

[3] Cucurbit, i. e., a matrass, or gourd-shaped vessel, originally forming the lower part of an alembic. F. L. J.

[4] Aquam ardentem sic facies: Recipe vinum nigrum, spissum et vetus, et in una quarta ipsius distemperabuntur unciæ II. sulphuris vivi subtilissime pulverizati; alb. II. tartari extracti a bono vino albo; unciæ II. salis communis; et subdita ponas in curcurbita bene plumbata et alembico suppodito distillabis aquem ardentem, quam servare debes in vase clauso vitreo.

[5] Hiernach stehen verzeichnet die ausgeprannten Wasser. In welcher maas die zu den gelydern nützen und brauchen sol. Alsdann Meister Michel Schrick doctor der ercznei beschrieben hat und ist gut und nützlich zu wissen. Hiernach volget eine nützliche mater; von manigerlei ausgeprannten Wasser wie man die nützen und brauchen sol zu Gesundheit der Menschen. Und diss buchlein hat Meister Schrick doctor der ercznei durch liebe und besunder gebet willen erber personen als aus den büchern zusammen colligeret und geschrieben.

[6] Apothek für den gemainen man, der die Ertzte zu ersuchen, am gut nicht vermügens, oder sonst in der not, allwege nicht erraichen kan.

brandy into his (the decedent's) mouth, then will he speak before he dies."

"If brandy be poured into (the body of) the dead, the corpse will not putrefy, nor stink ever, whether on top of, or under the earth."

"Item: Whatever meat be rubbed with brandy, whether it be raw or cooked, that flesh will neither rot nor stink."

"Whatever person hath stone in the bladder, let him drink a little brandy of mornings, for that breaketh the stone which speedily cometh away and leaveth the man sound again."

"Whosoever drinketh brandy, though but one time in the month, regularly, the worm dyeth which grows in the heart, or lungs, or liver of mortals."

"Brandy be good, too, for that man whose head acheth him, and he who batheth his head therewith remaineth handsome and long young, for it maketh a good memory and inciteth the spirit and wit."

"Item: He who hath a cold, let him drink brandy mixed with wine (geprannt wein mit anderm wein), and he will anon be well."

"Item: He who hath troubled and red eyes, let him rub a little brandy on the brows, and when he goeth to bed, put a droplet in the eyes, and anon he will be sound and well."

"Item: He who is hard of hearing hath but to drop a little brandy into the ears to recover his hearing."

"He who is dropsied hath only to drink brandy, and rub some of it over and around his belly when he cometh out of the bath, and goeth and standeth by the fire, he will soon be better."

Some time afterward (in 1529) Schrick's pamphlet, bound up with a lot of recipes accredited to the highly renowned and well-learned (hoch berumbten wolerfarnen) Hieronymus Brunsweick, was published at Nuremberg, under the title "Apothek for the laity who cannot, on account of lack of property or otherwise, in cases of necessity, reach the doctors."

Still more original is a poem in praise of alcohol, which appeared in 1493, of unknown authorship. It is entitled: Those to whom brandy be of use or of harm, and how it (geprannt wein) may be correctly or falsely prepared. The title is cut in wood, and is illustrated with pictures of the uses of brandy. The text is printed in movable letters, and at the close (where "Finis" usually is placed nowadays) stand these words, "Gedruckt zu Bambergk Von marxem Ayrer. Unnd Hannsen Pernecker in dem Zincken werd Im LXXXXIII. Jar." (Printed in Bamberg by Marc Ayrer and Hans Pernecke. Put into the zincs (i. e., type) in the year '93).[1]

In the poem we are not only told the diseases and conditions for which brandy is useful as a remedy, but it describes the properties, tests for pureness, etc., of spirit of wine, its antiseptic qualities, and finally the phenomena superinduced by too great indulgence therein. We reproduce a few stanzas of the therapeutical properties ascribed to brandy (or "spirit of wine," as throughout, in all the prints referred to, the terms are used as identical). It commences by naming a lot of herbs to be put in the liquid to make a vulnerary wash, and proceeds thus (no attempt being made to preserve the meter):

"First lay these herbs in burned wine,
And make the brew both strong and fine,
Then wash the wounds therewith, and know
That sooner than common they will better grow."

"If he, that fearful of the stroke (i. e., apoplexy),
But drink the wine, his health will ne'er be broke."

"Whoso drinks it, whether or no he liveth long.
While he *doth* live, liveth ever young and strong."

"If one but rubbeth brandy on the head,
Lice and their nits will all be dead."

And so the "poem" continues—recommending "geprannten wein" as a panacea for sore eyes, toothache, headache, backache, and almost every other conceivable ill, as well as a prophylactic against them, provided it be but regularly and industriously "nipped." (We need not, however, pursue the translation further.—Translator.)

The poem is noteworthy in more respects than one. By word and picture, it shows us that as early as 1494 brandy had become a common drink among the masses, and that great scandals were publicly caused by its abuse. Even at this early date there were public houses devoted to the sale of spirits, and that these had an enormous and open patronage, to such an extent, in fact, that ordinances and laws became necessary to regulate the sale and use of the liquor. Our poet's description of the effects of too much brandy on the human system is quite comical, as are also his word sketches of topers whom he claims to have known. As far as the manners and habits of these gentry, were it not for the quaint old German idiom, full of obsolete and long forgotten words, the sketches might have been written yesterday, so true to life are they.

As another proof that at the close of the fifteenth century the drinking of ardent spirits in public tap rooms had reached enormous proportions, we may cite a police ordinance of the city of Nuremberg, dated 1496, which commences: "Since many individuals of this city are addicted to the use of brandy, astonishing abuses have arisen in that trade, and it has been concluded to firmly and earnestly decree that from now henceforth, on Sundays and other holidays, no person shall offer for sale or sell brandy, either in their houses, groceries (Krämern), shops, on the Market Place, open streets, or elsewhere in this city."

Landgrave William II. also ordered that "Whoever had brandy for sale in his house shall not allow credit, be it on holidays or work days. We order, moreover, that on the holy days no one shall expose for sale or sell brandy near to or in front of churches—this on penalty of the confiscation of his stock of brandy."

Landgrave Philip, in 1524, prohibited the sale of brandy, either by the dram or otherwise. In the "Amtsregister" of the House of Zelle, we find in 1578, the following notice: "Hans Müller and Hans Günter have begun to distill brandy and to keep the same on tap, against the express command of our gracious sovereign." In Frankfort-on-the-Main, in 1582, brandy was entirely forbidden, the barbers (who were also surgeons) having reported that "in the present heavy mortality, the use of alcohol has very deleterious results." Again, in 1605, the order forbidding the use of alcohol was revived. In 1595, for the first time, the Magistrates of Berlin imposed a local tax on brandy, which tax was, just three-quarters of a century afterward, by the Great Churfürst, following the example of England, France and Russia, converted into a state revenue.

[1] In the rhymes which follow, as in the text of Schrick, *h* and *e*, p and *b*, and *t* and *d*, are used for each other indiscriminately, as though identical in sound and value.

A NEW AUTO-TROLLEY FOR ELECTRIC VEHICLES.

BESIDES the regular electric automobiles there exists a class of vehicles driven by electric energy obtained from an outside source, such as the trolley cars, some types of automobile buses, and various other road vehicles. With the trolley cars, the current returns through the rails, and a single wire only is employed, but with the omnibuses and other vehicles, a return wire is necessary.

The overhead trolley system for carriages is less in vogue at present than the storage battery automobile; nevertheless, there are some places where it is in successful use, one of them being at Fontainebleau, where it is being employed to run an omnibus line.

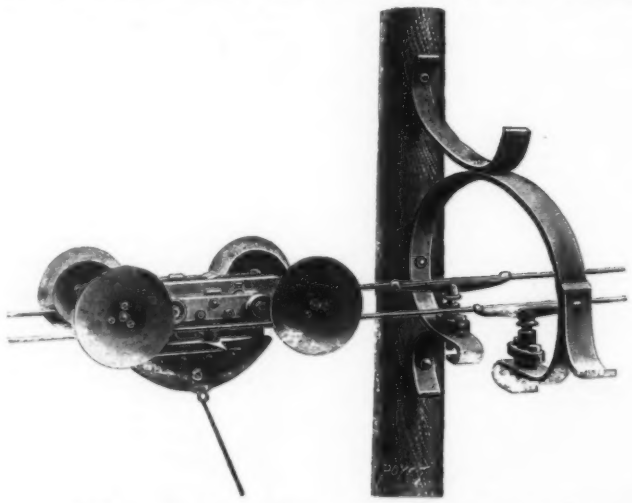
Various difficulties were met with when this system was first introduced by the Americans Cafrey and Marson and the Frenchmen Nave and Galliot. The problem is by no means the same as with street cars, which follow a fixed track. The electric vehicle must be able to move about on the road and not be obliged to remain on one side only, which, of course, necessitates an altogether flexible cable to connect it to the overhead trolley. Otherwise, the pull of the cable on the trolley might come at such an angle as to derail it, a thing that sometimes happens also if too great speeds are indulged in.

These difficulties have been overcome in some measure by the Lombard-Gerin auto-trolley, which was on exhibition at the Exposition of Vincennes, and which is the one in use at Fontainebleau. The chief fault of this auto-trolley is its weight, which necessitates a carefully constructed line with poles near together, making, on the whole, a rather costly installation.

The General Electric Construction Company has devised an auto-trolley which consists of a light frame supported on four grooved wheels patterned somewhat after the usual trolley wheel and adapted to fit on the two wires that conduct the current. Fastened on the frame is a metallic piece in the form of a star, which is constantly under the wire and keeps the wheels from jumping off. This guide piece is mounted on a vertical pivot, which allows it to turn and slip past the supports of the trolley wire, while a spring holds it in place afterward. Thus the trolley will always stay on the wires whatever the direction of the pull upon it.

A counterweight placed beneath the trolley counteracts the effect produced if there is a sudden pull on it along the wires, as when the carriage is starting. As long as the tractive pull of the carriage is less than the weight, the trolley remains stationary and the vehicle advances till the moment when the pull of gravity on the weight is exceeded by the effort of traction, in consequence of the obliquity of the line, which increases; the trolley begins to move at this moment.

The above described auto-trolley has the advantage of being simple, light, and cheap, which permits of the establishment of a line at an economical figure.—La Locomotion.

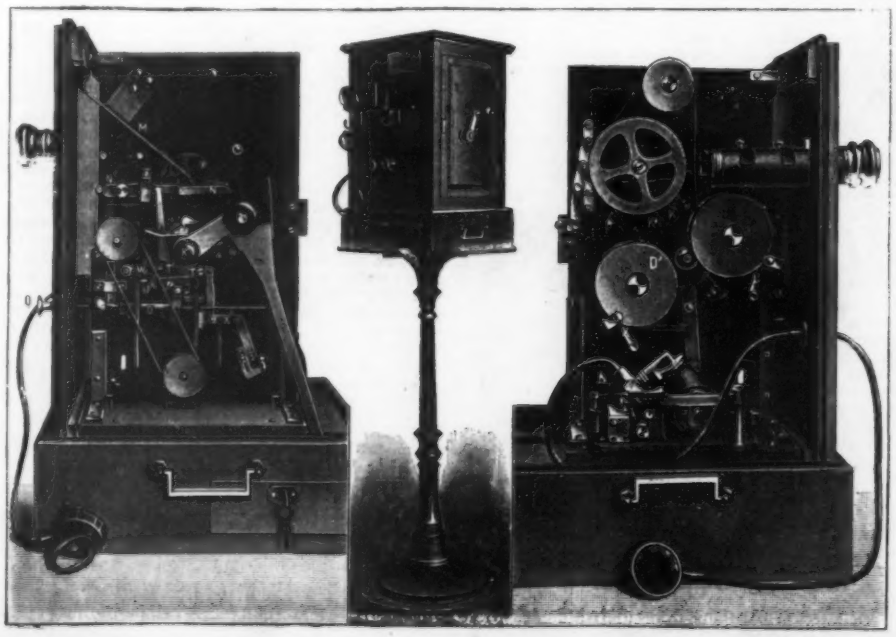


THE AUTO-TROLLEY FOR ELECTRIC VEHICLES.

THE AUDIPHONE DIOCINESCOPE.

OUR readers will doubtless remember M. Clermont Huet's "diocinescope," a curious apparatus which made its début at the Exposition of 1900, and of which we gave a detailed description at the time.

The diocinescope consists of the following essential parts: (1) A drum carrying on its periphery a number of juxtaposed divergent lenses; (2) a second drum connected with the first and on the same axis with it, which carries along the successive negatives of the band of film; (3) a reflecting system (prism with parallel faces) interposed between the two drums and designed to send the images in the direction of the corresponding lenses; (4) a convergent lens forming part of the reflecting system and correcting the aberrations of sphericity of the divergent lenses; (5) an arrangement of prisms with parallel faces and a lens, interposed between the image and the observer's eyes, so as to produce two images at a proper distance apart to fit the eyes and thus assure binocular vision; and (6) a mechanical method of controlling the drums and film spools and permitting of easily winding the film from one spool to another without changing the direction of rotation of the winding handle. This instrument, which is nothing more than a cinematoscope permitting of a direct view of the images, is capable of being so arranged as to operate automatically after the manner of the coin-in-the-slot apparatus that are now so numerous. In fact, such a transformation has recently been made by M. Huet, who has completed his apparatus by combining a graphophone therewith, so as to permit the spectator while witnessing the different phases of the scene



THE AUDIPHONE DIOCINESCOPE; GENERAL VIEW AND DETAILS OF MECHANISM.

registered upon the band of film to hear synchronously a piece of music, a song or a dialogue appropriate to such scene. Although the idea of the realization of the "audiphone diocinescope" was in itself quite simple, it nevertheless presented, from a practical standpoint, numerous mechanical difficulties, which M. Huet has ingeniously surmounted.

It is easy to understand the obstacles that M. Huet had to conquer in devising his apparatus by rapidly examining the manifold functions that the latter has to accomplish simultaneously or in succession.

In order to meet all the requirements of an automatic apparatus that is to be set in motion by a coin dropped in a slot the parts of the audiphone diocinescope must be so combined, in fact, as to perform the following different operations. It must be so installed that, through the simple introduction of a coin of a determinate value, the system can be disengaged and the film wound upon a spool may be unwound by means of a handle and obliged, before winding around the receiving spool, to pass over the actuating drum, which is operatively connected with the drum that carries the lenses. But this is not all. It is necessary also that, without the spectator having to do more than to turn the handle always in the same direction, the band of film, after being entirely unwound, shall move in the opposite direction so that the following spectator may, in his turn, have an integral view of the cinematographic scene. The reversal of motion of the system must therefore be automatically assured, and that, too, at the precise instant at which such reversal becomes necessary. Moreover, the crank must be so arranged that it shall cease to act upon the motive mechanism of the apparatus when, in consequence of the reversal of the latter's movement, the film has been rewound upon the first spool. The system should then be thrown out of gear and be capable of being started only by the deposit of another coin.

If it did not conform to these conditions the instrument would quickly get out of order. It is necessary, moreover, that not only the operation of the phonograph combined with the diocinescope shall be assured, but also that the operation shall be so regulated that the winding up of the phonograph shall be effected through the turning of the handle, and that the displacements of the cylinder and diaphragm shall be in continuous relation with that of the band of film; so that, just at the precise moment at which the latter finishes its motion backward, the diaphragm of the phonograph shall return to its initial position and be ready for another repetition.

It will be readily seen that, in order to bring about so complex a combination of motions, M. Huet has had to devise a mechanical arrangement which although complex is quite simple in its parts and as strong as necessary for an apparatus that is to be left to the free disposal of everyone without any surveillance.

The operation of the apparatus is as follows: Into the slot of the latter the observer introduces a coin, which, guided by the chute, *M*, falls upon a tray, *N*, mounted at the extremity of a lever, *N'*, and thus causes the ascent of the bolt, *P*, which frees the rod, *Q*. The observer then draws the latter toward him by means of the external button, *Q'*, and this has the effect: (1) of freeing the driving shaft, *K*, (2) of disengaging the pawl, *T*, of the ratchet, *T'*, so as to throw the graphophone into gear through the lifting of a catch, and (3) of causing the wheels, K^3 and K^4, to engage with those corresponding to the forward motion of the film. The apparatus is then ready to operate, and, upon turning the handle, the observer witnesses the passage of the various pictures, which, through their rapid succession, give the reproduction of an animated scene, while at the same time, by placing the receivers to his ears, he hears the graphophone.

After the forward motion of the film is finished the direction of the motion is automatically reversed through the angular displacement communicated to the lever by the arm, W^2, the result of which is to assure the engaging of the wheels, K^3 and K^4, with those corresponding to the backward motion of the film. The observer, while continuing to revolve the handle in the same direction, therefore sees the same scene unfolding in an opposite direction, the graphophone being always actuated. Such a combination of motions, moreover, has the effect of permitting of the descent of the bolt, *P*, for the purpose of rendering the rod, *Q*, immovable and preventing the latter from being acted upon until another coin has been introduced into the slot.

Finally, after the film has finished its backward motion and has unwound completely from the spool, *D'*, the bent lever, X^2, receives from the lever, *X*, an angular displacement the effect of which is to cause the pawl, *T*, to engage with the ratchet, *T'*, so as to render the shaft, *K*, immovable and thus completely stop the running of the apparatus. This same angular displacement of the bent lever, X^2, has the further result, upon the raising of a pawl, of permitting the catch to fall back and cause the disengagement of the graphophone, the diaphragm of which is then pulled back to its starting point by a spring. For the above particulars and the illustration we are indebted to La Nature.

"AMMONAL"—A NEW HIGH EXPLOSIVE.

By G. ROTH.

"AMMONAL" is the name of a new high explosive, claimed to be powerful in its effect and safe in use. The explosive contains no nitrified substance, but is a mechanical mixture of nitrate of ammonia and aluminium. It is less liable to absorb moisture than other powders of its class and keeps well when properly packed.

The explosive is not only a blasting compound for industrial and mining purposes, but also a military high explosive of rare excellence. When used either in mines or in ordnance, both safety and enormous power are obtained. So far as its industrial use is concerned, the most striking feature of the explosive is the total absence of noxious gases, for which reason it is most fit for blasting in pits and quarries.

Picric acid and wet guncotton, explosives most commonly used in shells and torpedoes, require a strong detonator (about 2 grammes of fulminate) for thorough detonation. It is claimed that "ammonal" is the only high explosive which can be brought to complete detonation by a simple black powder priming, producing the same effect as if a fulminate cap had been used. But where a fulminate detonator is considered preferable to a black powder priming, as, for example, in torpedo charges or submarine mines, one gramme of fulminate is all that is required to detonate the charge.

During the course of the year, a series of experiments were made before the officers of the Austrian navy, and before a foreign official (Capt. Tulloch of the Royal Artillery, England) in order to demonstrate the high efficiency of "ammonal" for military purposes. From 100 to 500 fragments were obtained by bursting a 12-centimeter steel service shell (1.21 kg.) with a bursting charge of 1,300 grammes of "ammonal." It must, however, be borne in mind that the absolute number of fragments obtained signifies nothing, if the proportions of the weight of the charge and weight of the projectile and the nature of the steel are unknown. Experiments made with 10.4 cm. howitzer shells (1.12 kg.) on the proving grounds of the Austrian Ordnance Board within the last two months, in order to ascertain what was the fragmentation in sand and the effect of the firing against earth cover, showed undoubtedly that "ammonal" is much stronger than the Austrian ecrasite, a picric acid compound.

Steel shells were also fired from a 47 mm. Skada rapid-fire gun against a 30 mm. steel plate, with a 60 grm. charge of "ammonal" and a small black powder priming. Perfect explosion was obtained behind the plate. There was no fuse in the shell, the black powder being exploded by the shock against the plate, and the fire transmitted to the "ammonal" and retarded.

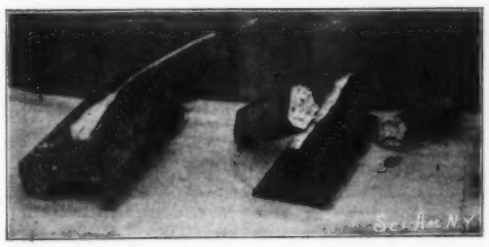


FIG. 1.—EFFECT OF THE EXPLOSION OF A 50 GRAMME AMMONAL CARTRIDGE ON A STANDARD RAIL.

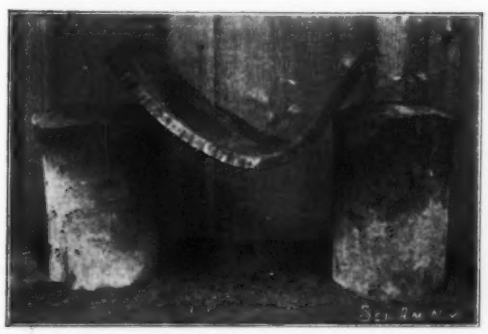


FIG. 2.—EFFECT OF 500 GRAMMES OF DYNAMITE DISCHARGED ON A 14 MM. PLATE. PLATE MERELY BENT.

FIG. 3.—EFFECT OF 200 GRAMMES AMMONAL DISCHARGED ON A 14 MM. STEEL PLATE.

SOLUTION OF TAR OIL FOR IMPREGNATION OF WOOD BY THE RÜTGERS PROCESS.

THIS solution is obtained in the following manner: In a machine of transverse movement, 100 parts of resin oil, either crude or refined, and as cold as possible, are mixed with 100 parts of sulphuric acid containing a little anhydride. By setting free a small quantity of sulphurous acid, the resin oil becomes dissolved in sulphuric acid. An almost homogeneous mixture is formed of sulphuric acid, of compound resinous ethers, and of sulphuric acid, which is decomposed by the addition of limited quantities of water. Two layers are obtained, the lower consisting of dilute sulphuric acid, and the upper containing nearly the entire amount of the acids of the compound ethers, with a very little free sulphuric acid, and the resin oils which should not be dissolved. It is then heated for a considerable time, which produces the separation of small quantities of acid. The upper layer is neutralized by a moderately diluted solution of sodium or potassium, and water is added in such an amount that the whole constitutes about 200 parts. The liquid, which is only slightly turbid from the small quantity of separated bodies, is then mixed with an equal quantity of tar oil, and water is added, so that the desired degree of dilution of the impregnating liquid is obtained.

It is still better to proceed in such a manner as to increase the free acid of the compound ethers, before neutralizing by the alkali, with an equal or greater quantity of tar oil. By then adding water in definite quantities, the separation of all the remaining free sulphuric acid is so obtained that all formation of alkaline sulphates and their harmful action on the solution of tar oil is prevented. The solution is neutralized and the desired quantities of water added.

It is of course understood that the patentee intends to designate the heavy oil of coal tar, which is employed in large quantities for the impregnation of railroad ties.—Translated from La Revue des Produits Chimiques.

THE NON-PHOTOGRAPHABLE.*

IT would save much wasted effort and disappointment if a list could be drawn up of what cannot be shown in a photograph. It never will be, to suit a majority, more than a list of things that produce indigestion. "Quot homines tot sententiæ," and what one would debar another would admit. In this case it means, on the face of it, rather a useless matter to discuss the subject. But it is far from being so in reality. Opinions are not of a cast iron kind, that once made admit of no change or alteration. A man may not alter a cherished belief suddenly from what he hears or reads, but something on the other side that he had not thought of, or had not thought of in another light, oftentimes makes an impression that will go far to modify and enlarge, if not in the long run to completely change, his original view. This is one reason why it is wise to ask advice. No one, at least very few, follow it unless it go well with the trend of their own proposed line of action, but very useful hints of what to avoid, or how to strengthen a weak point, are often gained, that help forward toward success.

So much in a general way is a reasonable justification for entering upon the enumeration of a few things that are really beyond photographic reach.

Spite of much honest but misdirected effort, attempting the work pure and simple of the artist shall take the lead. It is so far to the credit of a photographic worker that he feels so keenly the beauty and particular expression of an artist's representation as to wish to present his picture in the same manner. Apparent ease and simplicity are as misleading as the same qualities characterizing the work of genius in all directions. Owing to this, and the keenness of his appreciation, the photographer is more apt to lose the broader proportion of things that should clearly prove to him the impossibility of his task. The true artist does not present real things upon his canvas, but things real, and otherwise, after they have passed through the mills of his thought, feeling and imagination. These, in turn, are the result not only of an inherent inclination to tread in one particular direction at all cost, but of many years

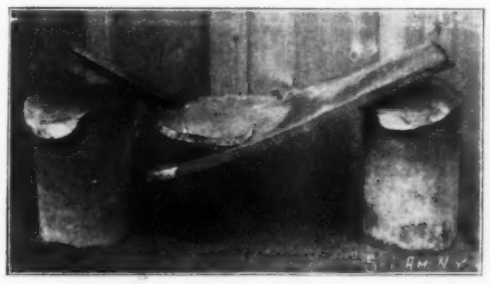


FIG. 4.—EFFECT OF THE EXPLOSION OF 280 GRAMMES OF AMMONAL LAID UPON A 14 MM. STEEL PLATE.

FIG. 5.—BLASTING-CARTRIDGE LAID ON A 14 MM. STEEL PLATE. BEFORE EXPLOSION.

* From the British Journal of Photography.

of training that has served to emphasize the features of the particular world he really lives in upon his soul. This is quite a different world to our work-a-day one, a fact made apparent enough when, as an eater of bread and cheese, he has to come into ours for it. His gods are as strange to us as ours are to him. Even were it possible for photographic methods of execution to equal the artistic, the particular mental training and absorbing predisposition of the artist are fatally lacking in the photographer. Small wonder that artists who feel all this should show such contempt for the rival efforts of disciples of the camera, plus the retouching desk and rough-grained paper. We should confine ourselves within our own true bounds; there is plenty of room there, and artists will not hesitate to approve of truth, fidelity and felicity of selection in photographic work, nor be backward in helping with valuable hints toward higher perfection. It is really a great pity that so many good men should not see things in this truer light, but persist in trying to convince themselves, and scornful larger intellectual and artistic circles, that smudges can be turned into pictures by suggestive titling. If so profoundly dissatisfied with the qualities of a photograph pure and simple that they cannot entertain it at all, a wiser plan would be to acquire a sufficiency of skill in the use of pen, crayon or brush, to be able to reproduce the photograph with any objectionable features or excess of detail left out. This is copying, it is true, and not art, but certainly much nearer it than the other class of work, both in aim and execution.

Turning to less debatable photographic territory, many things are technically possible of execution, but yet not advisable, that is, in pictures. Rapid motion and arrested action, for instance. If the object be to prove the rapidity of a shutter, the large working aperture of a lens, or gaining a scientific record, an express train traveling at full speed, with every wheel spoke showing clear; the bather in mid-air in the progress of his dive, or the hunter surmounting the hedge are most suitable subjects, but as pleasing pictures, anything but to the point. They have all an air of unreality that grates upon the feelings, for, while no human eye ever saw these things as represented, human reason can prove clearly enough that they must be true or the principles of optics and laws of light false. Slow motion, on the other hand, is eminently photographable, the flow of a quiet river, a ship under sail on a calm sea, a boat being punted up stream, a carrier's van, a timber wagon, cows in the lane on the way to or from the milking points, and so on.

Crowds and processions are disappointing in photographs, as may be very readily judged from those of recent ones welcoming our returning soldiers from South Africa. An artist can manage to give character to the whole by emphasizing a few members, and suggesting numbers with a minimum of detail; the camera gives not only every individual, but every individual button within its range.

The list of the non-photographable might be so indefinitely added to as to be discouraging. As this is decidedly not the object, but prevention of wasted effort leading to disappointment, as a co-relation to the foregoing it would be well to formulate as broadly as possible some conditions that make things photographable. Certain rules of composition in line and light and shade have been evolved from the long experience and practice of artists as the most pleasing to the eye, and the mind of which it is the window. Adherence to them means that there is nothing on edge, as it were, or toppling over. They give a sense of restful balance and agreeable proportion. There must, of course, be much more in a leading picture—action, suggestion or indication of human feeling; but even these must be judiciously balanced and foiled to be fully effective, and by much the same rules. These rules are the ones almost universally quoted as applying to photographic pictures. But just think for a moment of the widely different conditions of their application! In the simplest case of all, for instance, that of a peaceful landscape, with a machine intent only upon indifferently registering everything with the same hard and high precision, how can imperious classical rules be followed out? Something may be done by judicious selection of a point of view, but let those who have tried it give their experiences and show their results! In plain English, the rules of the artist with his power of selection are altogether unsuitable for the photographer. They overload him mentally as much as a suit of armor would physically. The only logical inference, then, is that there can be no such thing as a true photographic picture! Well, frankly, the writer believes there cannot in the highest artistic sense, except possibly by such an exception, an accident, as referred to above, and which will but go to prove the rule in forming the proverbial exception. There need be no derogation of photography assumed from this. In the first place, the perfect picture, by whatever means created, is much rarer than we would imagine, and when gained, however fine and beautiful, as a whole, we cannot but unconsciously concentrate our liking more upon one particular feature in it than its artistic and technical excellence as a whole. It may be a face, figure, pose, a group of trees, an old manor house, a noble-looking hound, or horse, or stag, the suggestion of human emotion, distance, home, the seasons, or what not. That these are the strong points, apart from their setting, is proved by the interest aroused by the lighter sketches and studies made by the artist preparatory to painting the full picture. Are they, indeed, not so strong that, when privileged to see them, we often wonder why even a better picture could not have been made out of them! Here is a fair ground for the photographer. He can show similar things to great advantage. But they must be treated in a similarly broad, simple manner to be correspondingly effective. The old manor house taken with the fullest practicable aperture at the best distance for the suppression of the most minute of the detail any way, and vignetting finally utilized to cut off everything that would weaken interest in the central object desired. A fine dog's head against a plain background makes a far finer picture than that of a terrier standing on a drawing-room chair, and a horse successfully snapped off in the paddock is well worth looking at. Many a church tower makes a delightfully pleasant little study that misses its aim if the whole church be attempted as a picture, and an angle of the pier can be made far more seasidy than a view of the whole pier and beach. In portraiture a head and face can be taken without the distracting frills and folds of the fashionable dress, and even the most frivolous photographer, one would imagine, would take the former to be essentials.

All, then, are not pictures in the orthodox sense, but what matters it if they are what we like best? They are generally of simple, bold subjects in foreground or near middle distance, with inevitable obtrusive objects vignetted off to the last possible point. The camera gives liberal ease, rapidity and truth in the execution of its work, but the necessary tribute to its mere mechanics must also be borne in mind. If this be willingly paid, instead of being fought against in a vain effort after the barely possible or really impossible, much more satisfactory results will be gained and without any disagreeable mental friction.

DAYLIGHT ENLARGING OF PHOTOGRAPHS.*

MANY workers are deterred from employing daylight for enlarging by the belief that it means interfering with the structural portions or fittings of a room, such as having to cut apertures out of window shutters and to rig up outside the window some form of ungainly reflector which would prove an eyesore to neighbors. This idea is quite erroneous. The fact is the utilizing of any ordinary room for the purpose of enlarging is a matter of much simplicity and does not entail an amount of skill greater than is possessed by any ordinary individual and does not mean the cutting of window shutters or rigging up any outside reflector at all. Most people can, with the aid of a hammer and a few nails, knock together with a few pieces of wood an inner frame that will fit tightly so as to shut out all daylight, and then provide an aperture in the frame to admit light through the negative; while the light may be diffused not by means of an outside reflector, but by placing a sheet of ground glass a few inches in front of the negative.

Not the least of the several advantages which daylight possesses over artificial light lies in the ease and centainty of obtaining an equal illumination over the surface of the negative. It is well known that by means of condensers used in conjunction with artificial light it is difficult to obtain an equal illumination, and it takes a very expert operator to detect when a negative is not properly illuminated, although it may appear so to any one unaccustomed to the work. This fact will be very soon realized when exposures come to be developed. On the other hand, when even such a simple means as the interposition of a sheet of ground glass between the negative and the light is resorted to, and daylight employed, a most beautifully even illumination of the largest-sized negative is the result.

A worker will not be long before he finds out that one of the chief factors toward success, after he has provided an effectual means for evenly lighting his negatives, lies in that one word exposure. Here there is very little latitude, if only the highest class results are to be turned out. It must be borne in mind that no two negatives will hardly ever be found which require the same treatment as regards exposure, and there is only one royal road to success, viz., by running a pilot and carefully seeing that no alteration in the power of the outside light has taken place since the trial piece was exposed, exactly the same developing solution being employed in all instances. One of the best plans to adopt for gaging the correct exposure undoubtedly lies in a free use of strips of the same sample of bromide paper that it is intended to employ for the final enlargement, and it will be found to be true economy to cut up into long strips a sheet of the paper, placing them over the densest shadows and strongest high lights displayed upon the enlarging board or easel. One strip of paper may often be cut into three or more portions and varying times be given to each. On development it will be strikingly evident which is right and which is wrong.

Since the introduction of such excellent samples of bromide paper, one of the great charms in enlargements produced with their aid lies in the purity of their color when metol is employed as the developer, and with many workers this chemical has been adopted in preference to ferrous oxalate, which reigned supreme for so many years. It is a mistake to suppose that the changes can be rung in respect of color by altering the developer. Pure high lights and good shadows can be obtained only by closely watching for the right time in exposure. Overexposure means nasty greenish-yellow, and underexposure produces general weakness of image, with poor, weak densities in the shadows, so that a worker would do well to realize the importance of finding the correct time to give, according to the stretch of the picture and the density of the negative.

Next to the importance of producing images of good color comes that of providing as sharp results as the negative will yield, and there is more in this than many might imagine. A suitable lens must be employed, i. e., one capable of covering well the size of negative being enlarged; and if, as often is the case where portrait combinations are employed, spherical aberration be present, the lens must be stopped down considerably. One of the advantages attaching to the employment of portrait lenses lies in the comfort of being able to see the image clearly on the easel by reason of the amount of light they pass when the focusing is being done with their largest angular aperture. Many excellent objectives are, however, condemned in respect of covering power, when, in point of fact, the fault does not lie with them at all, but actually with the operator himself. In work of this description the focusing is performed often by means of a front-extension camera, and if the utmost care is not observed in placing the negative and rising front of the camera which carries the lens absolutely parallel to each other the enlarged images will suffer in respect of sharpness, and nine times out of ten either the negative is blamed for want of sharpness or the lens is not covering properly. A worker would do well to experiment in this matter by seeing how small a lack of adjustment of the lens to the true plane of the negative will throw the image out of focus on the screen or easel.

To enable focusing to be accurately performed there is no better plan than inserting a sheet of finely ground glass on the screen that carries the sensitive paper, and at the same time, after the image has been brought to its utmost sharpness, finally examining the outside part of the image on a sheet of clean paper the same size as the sensitive sheet that is to be employed. Many negatives will come to hand for enlargement that are quite unsuitable, and there will be those also that require dodging in exposure, i. e., some parts will require shielding, so as to let the denser portions come up. A very little practice will teach a novice the enormous power that an operator possesses in this respect. A small piece of cardboard or a sheet of green glass wafted in the proper position in front of the lens, i. e., between it and the easel, will work wonders in producing high-class results, and in some instances, where the peculiarities of a negative are unknown, it is worth while to pull off a silver print from it and study closely the behavior of the negative during printing; by this means, especially where enlargements of considerable size are produced, money will be saved by seeing where certain precautions must be taken to shield portions during exposure. Some delightful results are obtained by vignetting. This is easily performed by inserting suitable cut-outs at a proper distance from the sensitive paper. These cut-outs, masks or vignettes are sometimes conveniently held *in situ* by nailing them onto a box which has its top and bottom cut out, the box containing the vignette being placed on some support in front of the lens at the proper distance from the easel, or they may be nailed on to an upright rod having a heavy base, which will keep them in the exact position desired.

In developing it is important to observe, when first soaking the paper in water, to cause it to lie flat, that all parts of the paper are equally damp. When operating on very large sizes it is at times difficult to get the entire sheet absolutely flat on the bottom of the developing trough; but with small sizes, where handy dishes are used and plenty of developer applied, this is not so liable to give trouble, and it is useful to have at hand a broad camel's hair brush to guide the developer somewhat, but the best results are obtained when a plentiful supply of developing solution is applied dexterously and kept constantly flowing over the surface of the sensitive image. Development by brushing is a particularly nice parlor or classroom experiment to show amateur workers, and, for small sizes, often yields nice results, but when working on large images it is fatal to high-class results unless an elaborate amount of working up has to be eventually performed. A brush is a useful adjunct for the developing table, but a plentiful supply of developing solution is the sheet-anchor where nice, level results are at stake.

* From the British Journal of Photography.

HOW ANIMALS AVENGE THEMSELVES.

VENGEANCE, when it is legitimate, is a manifest act of justice, for it implies in the animal the necessity of chastising a subject that has not conducted itself in a correct manner. This feeling is highly developed in the elephant, and no animal holds a grudge more tenaciously nor wreaks vengeance in such earnestness.

A Capt. Shippé having given an elephant a sandwich, the butter of which was impregnated with cayenne pepper, returned to pay a visit to the animal six weeks afterward and began to lavish caresses upon him. The elephant received him in the first place as an ordinary visitor, but in a few moments filled his trunk with dirty water and deluged the officer with it.

The following anecdote is related by Griffiths. It was in 1805, at the siege of Burtpore. The dry and hot winds had dried up the springs and there was a great competition around a large well in which there was as yet some water. One day while two drivers were near the well with their elephants, one of the animals, which was of remarkable size and strength, seeing the other provided with a pail that had been furnished her by her master and that she carried at the end of her trunk, snatched it away from her. While the two drivers were joking with each other, the victim, conscious of her inferiority as regards strength and size, concealed her resentment over an insult of which she was evidently very sensible, but which she soon had an opportunity of avenging. Choosing a moment at which the other was presenting her side to the well, the little elephant quickly drew back a few steps with a most innocent air, and then, rushing forward, butted her head against her enemy's side and tumbled her into the well.

The following anecdote relative to an elephant called Chuny is told by Rev. Julius Young. One day, a person after having foolishly amused himself by teasing the animal and offering him lettuce, a vegetable to which he had a great antipathy, finally gave him an apple, and, at the same time, stuck a pin into his trunk, and then promptly got out of the way. The keeper, seeing that the animal was beginning to get angry, and fearing that he might become dangerous, begged the sorry jester to leave the spot, which he did. But, after spending half an hour in persecuting humbler victims at the other end of the gallery, he returned to Chuny's side, and, as he had forgotten the pranks that he had played upon the animal, unsuspiciously approached a cage standing opposite. Scarcely had he turned his back upon the elephant when the latter, passing his trunk through the bar of his prison, seized his tormentor's hat, tore it in pieces and threw the remnants in his face with a loud bellow of satisfaction.

Facts of the same nature are related of the dog by a writer in Cassel's Family Magazine. A farmer of the suburbs of London was accustomed to go every morning to sell his milk in the nearest village. He never started on his journey without being accompanied by his dog, the business of which was to guard the wagon. This animal, at first sight, evoked but little sympathy, since he was not of a choice breed, but, on the contrary, was an animal of very low origin, to which his master had given the name of Victor. He

was constantly guilty of misdeeds that a dog of pure breed would never have committed. When a dog weaker than he was met on the road, he never failed to attack him and bite him until the blood came; but he was proportionally circumspect in the presence of an adversary capable of matching him, and before a bull dog or Newfoundland he always lowered his colors. Victor was the terror of small and medium-sized dogs for several months; but a day came when the cup of his iniquities was full. One of those deep agitations that precede supreme resolutions manifested itself among the representatives of the canine race, and a pack of terriers, hounds, spaniels, curs and poodles having formed spontaneously upon the public square, swept forward at sunset like a whirlwind toward the tyrant's abode. On the following morning, the milkman found his dog stretched out in front of the gate of his farm. The unfortunate animal, covered with wounds, had lost nearly all of his blood and lay almost inanimate; and it was only by dint of care and after a lengthy convalescence that he was able to resume his service. The old victims no longer recognized him. Victor had become another dog, and had profited by the severe lesson that he had received. Instead of jumping to the right and left upon the harmless pugs and timid harriers that he met upon his way, he trotted behind his master's wagon and no longer had any other ambition than that of defending the horse, vehicle and milk against the attempts of thieves. Rightly condemned by a jury of dogs, which took upon themselves the execution of the sentence, the criminal had been brought to a better state of feeling. Far from falling back into his old errors and becoming a hardened criminal, he had amended his ways after undergoing his punishment.

An English clergyman tells a story of a cock in a poultry-yard which, desiring to keep all the food for himself alone, drove the ducks away from the pan with vigorous blows of his bill. But the ducks at length revolted, and, after laying their heads together in a corner, formed a circle, which gradually closed in upon the tyrant. The latter, crushed on every side, was obliged to flee, being only too happy to get off so easily. From this day on, the ducks were able to eat their food without being disturbed by the cock, which was now thoroughly abashed.

The spirit of vengeance is highly developed in monkeys also. The following example is borrowed from Charles Darwin. Sir Andrew Smith, a zoologist of well-known accuracy, states that on one Monday morning, at the Cape of Good Hope, he saw a baboon bespatter an officer who was on his way to parade. He was an enemy of the monkey, which had often had to submit to his teasing, and which, seeing him approaching this day, hastened to pour some water into a hole and mix mud therewith for use as a missile. For a long time after this act of vengeance, the sight of his victim was for the animal a signal for rejoicing. Analogous anecdotes abound, and we might mention some relating to parrots, which quickly recognize those who have done them a bad turn.—Henri Coupin, in A Travers le Monde.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Utilizing Beet Residue and Sawdust.—The development of our infant beet-sugar industry (with its thirty factories that produced 371,000 tons of sugar last year, valued at nearly $8,000,000) raises the question as to the best means of utilizing the residue of the beets, which, in the European factories, is called "melasse." In the last decade, commencing with August, 1890, the world's production of cane sugar was 2,850,000 tons, against 5,950,000 tons of beet sugar. In the European factories sugar to the extent of 12 to 13 per cent of the weight is extracted from the beets. Much of the melasse is converted into alcohol, while another method of using it is as an ingredient of animal food, especially in the so-called "Torfmelassefutter," or peat and melasse mixed. The residue of the beets is said to contain about 50 per cent of uncrystallized raw sugar. The European demand for this class of animal food exceeds 75,000 tons yearly, at an average price of $1.78 per cwt.

Cattle Food.—At the patent office in Berlin, an application is pending which provides for the utilization of sawdust in combination with melasse as a food for animals. This may savor of the tale of the farmer who applied green goggles to his horse and fed him on sawdust, with the well-known result; yet the analytical table of nutritious matter contained in wood that is appended to the patent application is remarkable, when compared with that of straw. Chopped straw is used in Europe in considerable quantities to feed to animals in mixtures, and, according to the analysis, prepared sawdust would be more nourishing than straw. The inventor kindly put at my disposal the claims set forth in his patent application, of which I give a translation:

Procedure for Producing an Animal Food from Sawdust and Melasse.—In the rational economics of the farmer, science and modern technic play a great part. The observation has frequently been made that animals have a decided liking for young shoots and roots of shrubs, as well as the stems of Indian corn and sunflower stalks, all of which are easily digested. Experiments of long standing have proven that the nutriment contained in the shoots remains the same after they become wood. When certain chemicals—salt and calcareous water—are added to sawdust or ground corn cobs and stalks that have undergone a certain fermenting process, the resultant product is a food for animals that is easily assimilated and digested, and is liked by cattle, horses, sheep, and pigs. The valuable properties of this prepared food are based upon the nutritious matter contained in the wood (which is set free by the fermenting process), mixed with a large percentage of melasse.

The inventor, Mr. Heinrich Reh, Wilhelm Strasse 271, Berlin, Germany, is ready to give further information to interested parties.

Fuel.—Sawdust in cake form as fuel has been produced in Prussia. These are octagon-shaped bricks, 6½ inches long, 3½ inches wide, and three-fourths of an inch thick; weight, one-half pound each. In the district and surrounding towns where the factory was located, the schools were heated by this fuel, which burns in air-tight stoves without a large flame, and leaves but little ash. It is an ideal fuel, being clean, and no regulating of the stove being necessary. No binding ingredient is used; the sawdust is dried and pressed in the shape of the briquette. The absence of all tarry or oily substances prevents smoke. The weight of such a briquette indicates the heavy pressure under which it takes its shape, and the edges look like polished oak; in fact, it is heavier than a piece of hard wood of the same size. The demand created by the popularity of this fuel exceeded the supply of sawdust obtainable in the vicinity of the factory, so shiploads were procured from Sweden and carloads from distant manufactories. Sawdust which previously could be had for the asking, demanded a market price as soon as it became known that a certain factory could make use of it. Even then, it was profitable to manufacture the briquettes; but, unfortunately, the factory was destroyed by fire. Insurance troubles have delayed its rebuilding. I was enabled to procure a few of the briquettes and forward a sample. I am of the opinion that in our woodworking districts, the manufacture of sawdust briquettes without a binding material would pay well, and I am ready to furnish persons interested with the cost of the machinery necessary.—Adolph L. Frankenthal, Consul at Berne.

Scotch Tribute to American Skilled Workmen.—The Machinery Trust, organized about eight years ago, with a capital of £2,000,000, for the special purpose of controlling the manufacture and sale of printing presses in this country, has been gradually extending its influence over this branch of trade and also widening the scope of its operations. The Linotype Company was the nucleus of the trust, which rapidly acquired nearly all the important plants in Great Britain for the manufacture of printing presses and supplies; also the patent rights for this country on many foreign presses, and in other cases the privilege of making presses of foreign design for this market on condition of paying a fixed amount of royalty. A few years ago, the trust went farther afield, obtaining the sole agencies for as many foreign articles as possible; and this concern now has a strong grip on the machinery trade in the United Kingdom, still making a specialty of machines for the printing and publishing business. Some of the leading American presses and other American machinery for the printing trade are manufactured in England by the trust. This branch of the business is in its infancy, and I am told by printers and publishers that its success is by no means certain, as there seems to be much doubt about the quality of the workmanship. A large printing and publishing house in Edinburgh that has long had American presses, folders, stitchers, etc., adding to its American equipment every year, always buys its machines through the trust, but invariably stipulates that such machines must be not only of American design, but also of American manufacture. I am informed by a member of this firm that the superior skill of American workmen in fitting machinery of this kind is universally recognized in the trade here. Although assured by the trust that the material used in the manufacture in England is precisely the same as that used in the United States, and that the work is done under the general supervision of American foremen, still he and his partners refuse to place confidence in the English-made machines, distrusting especially the workmanship.—Rufus Fleming, Consul at Edinburgh.

Stone and Wood Paving in Edinburgh.—There is a growing demand in this city for the substitution of wood pavements for granite, especially in the principal streets where the traffic is heavy and noisy. But the municipal authorities, giving attention solely to the question of economy involved, are not disposed to extend the use of wood. Mr. David C. Proudfoot, city road surveyor, who has had long experience in the making and repairing of streets, informs me that the life of wood pavement on a main thoroughfare is ten years, while granite of the best quality will last thirty years if relaid once or twice; and as the cost of wood paving exceeds that of granite, the reason for the municipal preference for stone in street making is obvious.

Edinburgh is well paved. With an area of 16½ square miles, the city has 82 miles of granite streets, 2 miles of wood pavement, and about 80 miles of the best macadam. No asphalt has been laid, chiefly because of the broken, hilly nature of almost the whole area covered by the city, requiring street gradients which would, it is thought, render asphalt unsafe for ordinary traffic during most of the year.

The wood blocks formerly used for the few streets having this kind of pavement were infused with a creosote preservative—the common, heavy oil from iron-smelting works. A soft-wood block, 9 by 7 inches and 3 inches thick, would take in about 2 pounds of the oil under a pressure of 120 pounds per square inch. The present wood pavements are constructed of Australian "jarrah" hard wood, requiring no creosote, as it contains a natural oil. Blocks 9 by 5 inches and 3 inches thick are laid on a 6-inch concrete bottom with smooth surface, and jointed with cement grout or asphalt. This paving costs about $4.10 per square yard. Nine by 7 by 4 inches granite blocks laid on a 6-inch concrete bed and jointed with gravel cost $3.60 per square yard.—Rufus Fleming, Consul at Edinburgh.

Opening for American Machinery in Bohemia.—Nearly everything made in the United States could be sold in this district (Reichenberg), but the greatest opportunity of all is for spinning and weaving machinery. In previous reports, I have noted the absence of American machinery in Bohemia. Of the approximately 2,000,000 flax, wool, and cotton spindles and of the many thousand looms operating in this district, not one was made in the United States. Our consuls have at sundry times sought to change this condition by opening correspondence with makers of such machinery in the United States, but have never been able to persuade the latter to enter aggressively into the field. It is true they have always been ready and willing to fill orders, but unfortunately a merely receptive state does not answer. Most of the factory machinery in this district comes from Great Britain, some from Germany, and a small part is of local production. The field is so great as to be worth a vigorous and persistent effort to get a footing in it; but nothing can be done with circulars and trade periodicals, especially when printed in English. Industrious, German-speaking agents are essential; it would be better still to have resident agents on the ground, able to keep a watchful eye on the situation and to be constantly in close touch with factories.

During the past summer, a firm at Dresden, Germany, advertised American farm machinery in a Reichenberg newspaper. Soon thereafter, and possibly as a result thereof, I saw an American mower at work in a neighboring meadow—the first and only American machine I have seen in this district. But it is an entering wedge, and inspires hope for the future.

No reaper has yet invaded a grain field in this section, the sickle still holding sway in the harvesting of cereals, and thrashing is still done with the flail, wielded by women, who work in quartettes.—Frank W. Mahin, Consul at Reichenberg.

Exposition at Tetschen, Bohemia.—An exposition of general manufactures will be held at Tetschen, Bohemia, from July 15 to September 15, 1902.

Tetschen is a growing town of 10,000 population, located on the Elbe River. Its importance is relatively much greater than its size, as it lies close to the frontier of Germany, and customs examinations and train changes occur there.

Several public buildings will be used for the exposition, and space therein should be engaged by February 1, to insure against disappointment. Exhibits cannot be placed, however, before June 1, and must all be on hand by July 10.

It is expected that reduced freight rates for exhibits will be secured on the railroads and the Elbe River, and that the tariff laws will be suspended for their benefit.

The exhibits will be divided into twenty-seven groups, as follows: (1) Clay and glass ware; (2) building materials; (3) chemical products; (4) foods and drinks; (5) furniture and wooden ware; (6) textiles and clothing; (7) leather and hardware; (8) metal wares; (9) machinery; (10) musical instruments; (11) mathematical, physical, and surgical instruments; (12) paper, printing, and photographic products; (13) educational articles; (14) antique and modern art products; (15) agriculture and forestry; (16) garden and orchard; (17) navigation; (18) mining and smelting; (19) electricity; (20) travel; (21) hunting and sporting; (22) hygienic articles; (23) aids to progress; (24) fire extinguishers; (25) inventions; (26) amateur work; (27) politics.

The management of the exposition is particularly desirous of exhibits from the United States, and will offer every reasonable facility and inducement to secure them. All desired information can be gained by addressing Der Vollzugs-Ausschuss der Ausstellung, Tetschen, Bohemia.—Frank W. Mahin, Consul at Reichenberg.

Opening for American Overalls in England.—Not long ago, an American stranded here claimed that he could get work if he had a suit of workman's overalls; and in a moment of generosity I went out with the man, and, naturally enough, looked for the kind of overalls used by workmen in the United States—those with a continuation of the front of the trousers in the shape of an apron to the neck, and with cross straps serving as suspenders and buttoning on the rear of the trousers. These overalls have in the United States a big pocket across the chest for tools, and the costume is completed with the kind of coat used here. This type of overalls seemed to be unknown here; but I have since had as a caller at the consulate a tailor for the working classes, who does what he calls "a rough-and-ready trade." He has a son in the United States, and it seems visited this son last summer. He told me that when he was there he had noticed the overalls worn by American workmen, and had since made overalls of the same kind for some of his customers. He said there would be a large sale here for overalls of this type, made by machinery, provided they were made more carefully and of heavier and better material than that used in the United States; and that a correspondingly higher price could be obtained. British workmen, he said, cannot afford to wear overalls for a few weeks and then throw them away, as the American workman does, but must make them last a year, and therefore they must be of better material and "wash white."

It occurs to me this information may be of value to American manufacturers of overalls.—Marshal Halstead, Consul at Birmingham.

German Meat Inspection.—Ambassador White telegraphs from Berlin, December 23, 1901, that a committee of the Bundesrath has begun to consider a list of localities for the examination and admission of meat, according to section 13 of the new meat-inspection law. It is probable that this part of the law will not go in force for sime time, though as yet no specific information is obtainable.

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No. 1245. January 22. Emery Stone in Greece and Turkey—*Sake Brewing in Japan—*American Shirt Waists in England—*German Measures Against Tuberculosis.

No. 1246. January 23.—The Decline of Company Promoting in Scotland—Fire-Insurance Opportunities in Havre—New Antwerp-Cuba Steamship Service—Coal Prices in the Canary Islands.

No. 1247. January 24.—Taxation in New South Wales and New Zealand—Arbitration between Peru and Bolivia.

No. 1248. January 25.—Australian Tariff Changes—*Artificial Flowers in Saxony.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Excellent Glue for Uniting Metals with All Sorts of Fabrics.—Cologne glue of good quality is soaked and boiled down to the consistency of that used by cabinet-makers. Then add, with constant stirring, sifted wood ashes until a moderately thick, homogeneous mass results. Use hot and press the pieces well together during the drying. For tinfoil about 2 per cent of boracic acid should be added instead of the wood ashes.—Praktischer Wegweiser.

To Render Felt Waterproof.—Dissolve 1 liter of good pure linseed oil (not varnish), 1 liter of petroleum, ½ liter of turpentine, 125 grammes of yellow wax, the latter in small pieces, in a vessel, preferably of copper, over a bright coal fire, avoiding, however, a boiling of the mass, for fear of fire. With this hot solution saturate the felt, naturally as far removed from the fire as possible, hanging it up or spreading it out afterward in a warm, dry room in such a manner that the temperature acts uniformly on the surfaces.—Werkmeister Zeitung.

To Clean Gummed-up Parts of Machinery.—Owing to the machines being greased with fat oils the oil resinifies upon long idleness of the parts, so that their running is rendered very hard, especially for hand power. Regreasing with oil does not do much good, a thorough cleaning of the resinified places, bearings, eccentrics, shafts, etc., being necessary. Petroleum is known to have been used for dissolving the resinified oils, but is only useful for easily accessible, smooth parts, and even here with considerable difficulty. In those cases where there are hollows, oil holes, grooves, etc., rubbing with petroleum is insufficient. As a reliable remedy in such cases a strong soda solution is recommended. Take about 10 to 15 grammes of caustic soda or 100 grammes of soda for each liter of water, cause the solution to boil, immerse the parts to be cleaned in this and bathe them in it for some time, or, what is still better, boil them with it. The success will be so pronounced that only a rinsing and drying remains necessary to clean the machine parts. For small shops this mode of cleaning is doubtless the best.—Technisches Centralblatt.

To Mend Bursted Water Pipes.—Despite the greatest amount of care, it will sometimes happen that frozen water pipes will burst in thawing them out. Since the insertion of a new pipe entails a great loss of time and necessitates an interruption of the work, we will give below a process which enables one to render the pipe serviceable again in a few minutes at a moderate expense. The mended pipe will remain durable for a long time after.

It is essential, above all, to always have rosin and tallow on hand, as well as an iron crucible or fire-resisting stoneware pot, in which these materials can be melted. If one has the misfortune that an iron water pipe bursts, the water should be turned off at once. Then the pipe should be carefully filed off the whole length of the crack with a coarse, strong iron file in order to thoroughly free the surrounding portions from all rust, varnish, etc. Meanwhile heat in the above-named iron or stoneware pot equal quantities of rosin and ordinary tallow to fusion, stirring the mass thoroughly all the while. Apply a thick coating (about 5 to 10 mm.) of this liquid, hot mass on the carefully filed-off places to be repaired, using a hard brush; then wrap strips of old, coarse linen around the pipe, continually painting the pipe or the bandage with the colophony-tallow compound. The whole is still wrapped around a few times with packing cloth, while continuing to apply the liquid mass; and all is done. The injured place, unless the crack is exceedingly wide, will hardly allow any more water to pass through and the pipe will do service for years to come. The rosin-tallow mixture is preserved for further use and need only be heated to be ready for application.—Faerber und Waescher.

Extrait Edelweiss.—

Bergamot oil	10 grammes
Tincture of ambergris	2 grammes
Tincture of vetiver, 1 in 10	25 grammes
Heliotropin	5 grammes
Rose oil spirit, 1 in 100	25 grammes
Tincture of musk	5 drops
Tincture of angelica	12 drops
Neroli oil, artificial (Schimmel & Co.	10 drops
Hyacinth, artificial (Schimmel & Co.	15 drops
Jessamine, artificial (Schimmel & Co	1 gramme
Spirit of wine, 80 per cent	1000 grammes

Stove Varnish.—

Shellac	120 grammes
Manila copal	140 grammes
Rosin	120 grammes
Gallipot	25 grammes
Benzoin	10 grammes
Lamp black	50 grammes
Nigrosin, spirit-soluble	15 grammes
Alcohol	2500 grammes

To Attach Paper to Polished Metal.—

Dextrin	400 grammes
Water	100 grammes
Grape sugar	20 grammes
Aluminium sulphate	10 grammes

The whole is heated for 30 minutes to about 90 deg. C. to obtain the best adhesive quality.

Golden Beetle Varnish.—

Methyl violet	50 grammes
Fuchsin	25 grammes
Spirit	150 grammes
Polishing white	375 grammes

—Drogistische Rundschau.

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